SEP 30 1940

ENGINEERING NEWS-RECORD

SEPTEMBER 26, 1940

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ARMCO MULTI PLATE PIPE AND ARCHES

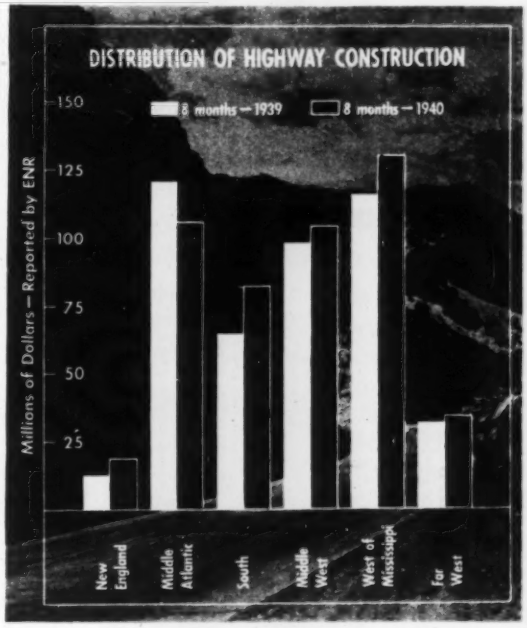
A TYPE OF PRODUCT ORIGINATED AND DEVELOPED BY ARMCO ENGINEERS

CONSTRUCTION TRENDS

Notes on significant movements in the construction industry

Highways hold to predicted gain

Engineering News-Record's estimate of 1940 construction volume at the outset of this year has undergone extended revisions since the advent of the national defense program. Street and road construction statistics to date, however, have remained remarkably close to the forecast of a 6 per cent increase as indicated by the state highway construction data published in the *ENR* Annual Highway Issue, Jan. 18, 1940.



Through August, current highway construction volume, $476,648,000, holds a 7 per cent edge over the corresponding period a year ago. This gain is well distributed, five of the six sections of the country recording increases.

The greatest gain is reported in New England, 52½ per cent above last year. Highways are up 26 per cent in the South, and play an important part in the new record for that area. The Southern state's 8-month 1940 total already exceeds the volume for the entire year 1939, the previous high.

West of Mississippi states report a 12 per cent increase in highway volume over last year; the Middle West total is up 6 per cent; and Far West is 5 per cent higher. The only section to show a loss, the Middle Atlantic states, is 12 per cent under 1939, when the bulk of the large contracts for construction of the $70,000,000 Pennsylvania Turnpike were let.

Highway volume is 22.4 per cent of the 1940 United States construction total. This compares with 21.6 per cent for the 8-month 1939 period. West of Mississippi accounts for 27.4 per cent of the year's highway construction; Middle Atlantic, 22.4 per cent; Middle West, 21.9 per cent; South, 17.3 per cent; Far West, 7.1 per cent; and New England, 3.9 per cent.

In the same 1939 period, West of Mississippi provided 26.1 per cent of the U. S. highway total; Middle Atlantic, 27.3 per cent; Middle West, 22.1 per cent; South, 14.6 per cent; Far West, 7.2 per cent; and New England, 2.7 per cent.

Highways for defense are the primary interest at the moment. The program outlined will require improvement or construction of 3,112 miles of access roads into some 120 cantonments and military reservations. These roads, to cost approximately $202,000,000, open up a new system of highway construction to roadbuilders.

Allocation of $163,000,000 in federal aid money for the 1942 fiscal year has been made three months earlier than usual, and there is a possibility that this fund may be made available to states before next July to speed up vital defense road construction. In addition to the authorization and allocations above, there is an unexpended balance of $197,000,000 in federal road money. The Public Roads Administration is permitted by a new law to require that this, as well as future money be devoted to defense projects.

These new financing factors may make *ENR's* forecast seem conservative later in the year.

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Write for Bulletin No. 494 on

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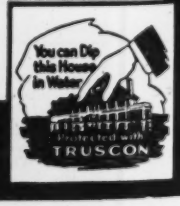

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F. E. SCHMITT *and* WALDO G. BOWMAN, *Editors* • ALBERT E. PAXTON, *Manager*

Vol. 125 SEPTEMBER 26, 1940 No. 13

THIS WEEK

Sewage Disposal Practice—Featured in this issue is a group of articles which should hold as much interest for municipal administrators as they do for sanitary engineers. These articles clearly show that the solution of problems in sewage disposal calls for a careful evaluation of economic considerations as well as ingenuity in design.

Flame Cleaning Steel for Painting—The ease and economy of applying modern methods of flame cleaning to steel, plus the resulting high quality of the treated surfaces for painting, are such that the process is rapidly growing in use. This article describes accepted technique and gives numerous examples with estimates of the amount of labor and material involved.

Underpinning Beats Subway Threat to Famous Chicago Building—The 17-story Monadnock Building is a bearing-wall structure carried on floating foundations. The underpinning of these foundations with caissons and the problems involved make one of the most interesting projects of recent years. Brick piers and combination brick and steel piers, loaded as high as 900 tons, are being carefully picked up through grillages resting on the foundation mats while Chicago well caissons are sunk 60 ft. to hardpan beneath the piers.

THINGS TO COME

Increasing use of salt or calcium chloride to clear icy roads has resulted in serious trouble due to concrete scaling. A study of this problem and its solution will be discussed by O. L. Moore, Director of Tests and Research, Universal Atlas Cement Co., in the Oct. 10 issue.

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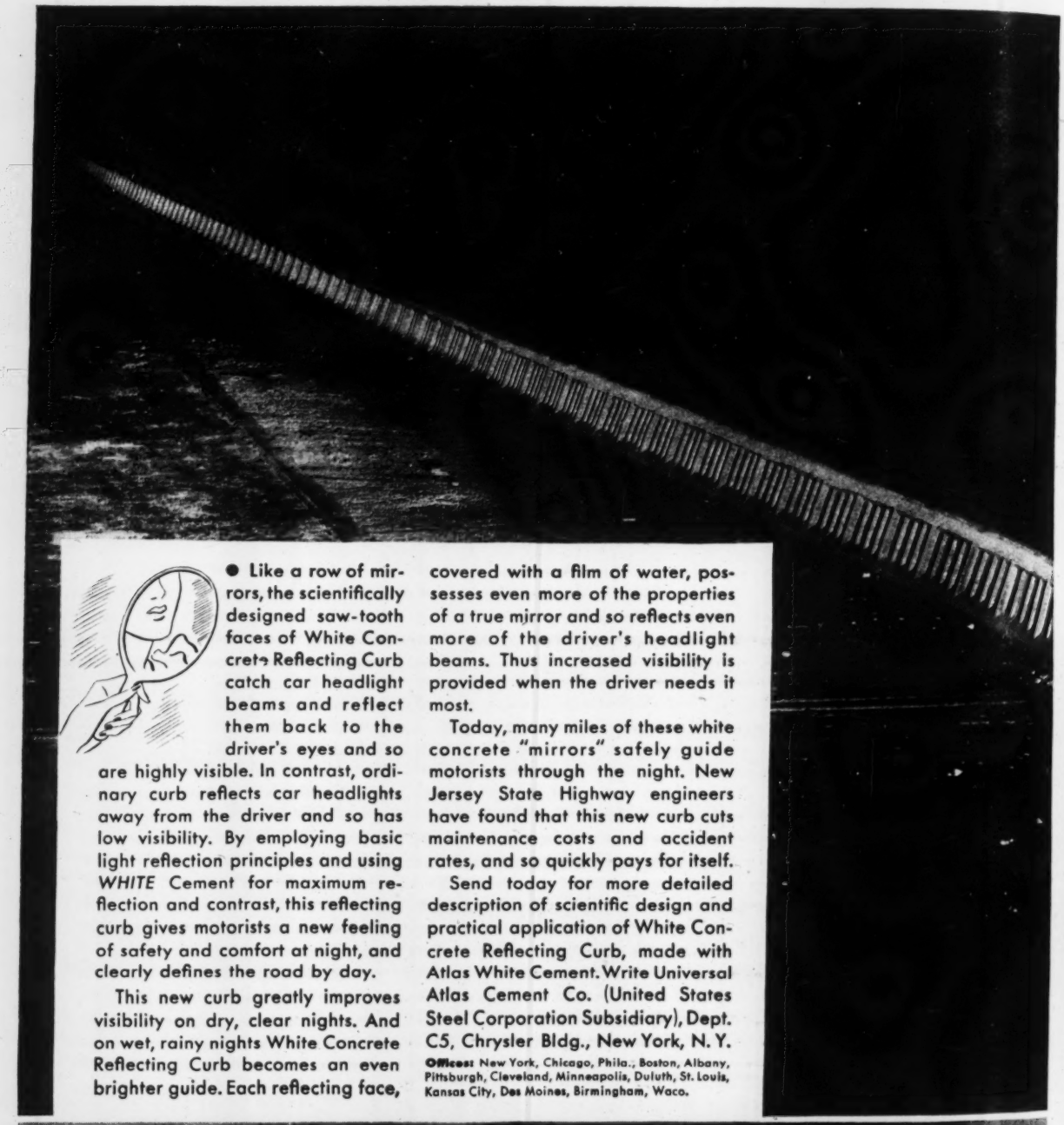
MIRRORS OF CONCRETE

for safer night driving!



● Like a row of mirrors, the scientifically designed saw-tooth faces of White Concrete Reflecting Curb catch car headlight beams and reflect them back to the driver's eyes and so are highly visible. In contrast, ordinary curb reflects car headlights away from the driver and so has low visibility. By employing basic light reflection principles and using *WHITE* Cement for maximum reflection and contrast, this reflecting curb gives motorists a new feeling of safety and comfort at night, and clearly defines the road by day.

This new curb greatly improves visibility on dry, clear nights. And on wet, rainy nights White Concrete Reflecting Curb becomes an even brighter guide. Each reflecting face, covered with a film of water, possesses even more of the properties of a true mirror and so reflects even more of the driver's headlight beams. Thus increased visibility is provided when the driver needs it most.

Today, many miles of these white concrete "mirrors" safely guide motorists through the night. New Jersey State Highway engineers have found that this new curb cuts maintenance costs and accident rates, and so quickly pays for itself.

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WHITE CONCRETE REFLECTING CURB

MADE WITH ATLAS WHITE CEMENT

State road officials discuss military highway problems

Annual convention of A.A.S.H.O. at Seattle marks beginning of federal-state cooperation to bring roads and bridges to military standards

Making highway systems conform to the standards required for military purposes was the dominant theme in papers presented at general sessions of the 26th annual convention of the American Association of State Highway Officials last week in Seattle, where a representative gathering from 41 states included some 550 members and guests. The four-day program was arranged so that small group meetings could supplement the general sessions. On two successive days the delegates split up into 12 groups which devoted attention first to papers and discussions, followed next day by sessions of the association's 12 standing committees (corresponding to the 12 groups) to formulate conclusions. On the last day of the convention reports were received in general assembly embodying conclusions of the standing committees.

A plea for state supervision

At the first general session the report of President Henry F. Cabell, Oregon, drew attention to the national defense clause in the recently passed authorization bill which empowers the commissioner of public roads to select and give preference to certain road projects. It is important that states should retain general control over initiation of projects, and final authority in the expenditure of funds which are only a fractional return of federal taxes on highway uses, should rest with the state highway departments, he said. Such funds should be expended through one central line of authority from the federal treasury through the Public Roads Administration to the state highway departments so that we have a straight line of responsibility. Funds other than those provided by the motorists should be used for roads built primarily for national defense; priority could rest with the proper defense agency, but even there only after consultation with state highway departments. A 30-per-cent sales tax on consumers of one special commodity, he said, carries with it a responsibility for expending the proceeds in the most economical and most efficient way possible to bring immediate returns. The association stands for the contract system and opposes indirect methods of expending federal highway funds.

More federal aid

Congressman James W. Mott of Oregon, member of the House committee on roads, stressed the fact that of the $350,000,000 per year collected by the federal government in taxes on users of highways more than half is diverted to other than road uses. When this diversion has been stopped, he said, the financing of defense highways will not be difficult.

Proper coordination of activity in our

(Continued on p. 33)

TVA turns on the heat to provide additional generating capacity

How the Cherokee Dam site appeared Aug. 1, the day after legislation was approved authorizing construction of the dam on the Holston River 30 miles northeast of Knoxville, Tenn., is shown at the left. The rapid progress of six weeks is illustrated by the picture at the right, of the same site, taken Sept. 14. This view shows the construction plant buildings in the foreground and in the background the first cofferdam area enclosed by earth dikes tying to the island to permit dry construction of the cofferdam proper.

Early completion of Cherokee Dam has been urged by the National Defense Advisory Commission. It will have an initial installation of three 30,000 kw. units. The dam will be 6,750 ft. long, including 4,800 ft. of earth dike, and is scheduled for completion in 20 months.

Lee G. Warren is project engineer, Geo. K. Leonard construction engineer and G. E. Murphy construction superintendent for the TVA.

Move begun for federal aid to cities for airport enlargement work

President asks Congress for funds to start six-year, $600,000,000, construction program drafted by Civil Aeronautics Authority

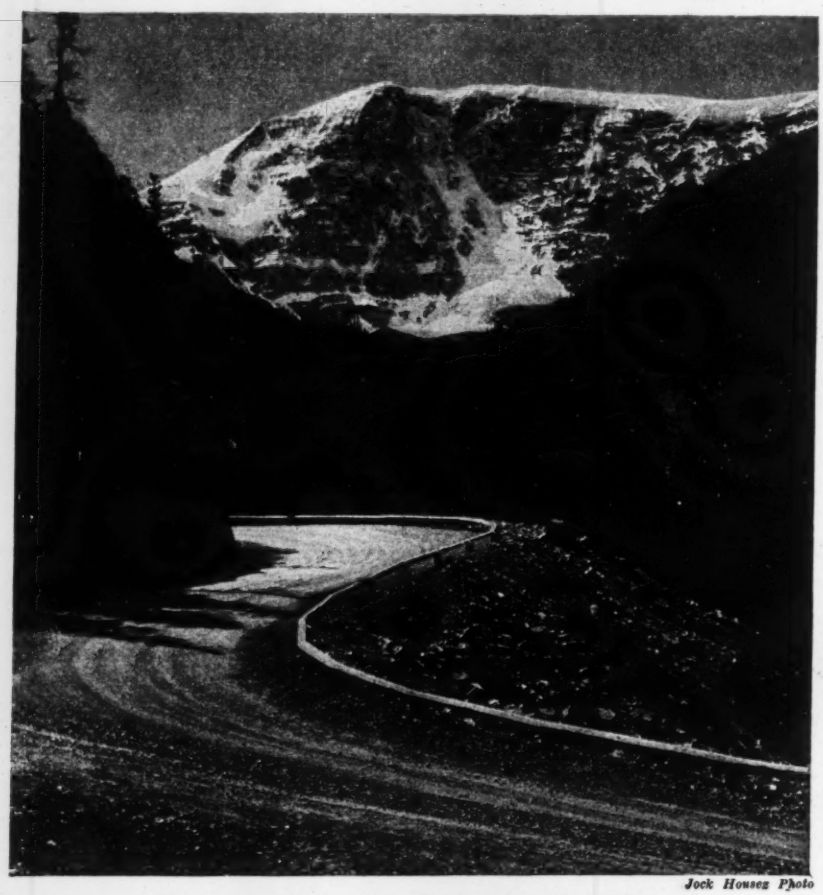
The President has recommended to Congress that it appropriate $80,000,000 for construction of civil airports and the House has included an appropriation of $30,000,000 and contractual authorization for $50,000,000 more in the civil functions deficiency bill. This is the first move toward regular federal participation in the cost of airfields. Considerable sums of federal money, more than $190,000,000 in the past seven years, has been spent on airports through the relief and PWA programs, this has never been recognized as a normal type of federal expenditure.

The present appropriation is intended to make a start on a six-year program of airport construction which has been drafted by the Civil Aeronautics Administrator and will involve total federal expenditures of about $600,000,000. It calls for construction of civil facilities located and designed with an eye both to civil and military needs. Work would be done in cooperation with municipalities —the cities putting up the land and erecting buildings, the government providing drainage, grading, paving, and lighting and radio facilities. This is substantially the same division of responsibility contemplated in a bill which has been kicking around Congress this session. The administration has now decided, however, that the original CAA act gives the administrator power to build airports without further legislation.

Much work planned

The long-range plan proposes to increase the number of high grade airports capable of handling all types of civil and military traffic from the present 36 to about 500. Medium size airports, now numbering 245, would be increased to about 1,600, while the number of small airfields would rise from 1,576 to about 1,900.

Projects to be carried out with the initial $80,000,000 have not yet been chosen. The selection will be made jointly by the Army, the Navy, and the CAA. Prime criterion at first will of course be strategic value. It is intended to piece out the appropriation by assigning WPA funds to the projects selected.



Jock Houses Photo

New roads in the Canadian Rockies

Located in two of Canada's national parks and built entirely with federal funds, the new 186-mile highway between Banff and Jasper, both resort towns in the province of Alberta, has added greatly to the area in the Canadian Rockies accessible by auto. Surveys, plans and construction of the road were under the supervision of the surveys and engineering branch of the federal Department of Mines and Resources in association with the parks and forests branch of the same department, which administers the national parks.

The road has a gravel surface and is built with a minimum width of 18 ft. The ruling gradient is 8 per cent. Starting at an elevation of 4,500 ft. above sea level at Banff, it rises to 6,675 ft. at Sunwapta Pass to drop to an elevation of 3,472 ft. at Jasper. The road connects at the Banff end with the newly-opened section of the Trans-Canada highway through the mountains to British Columbia.

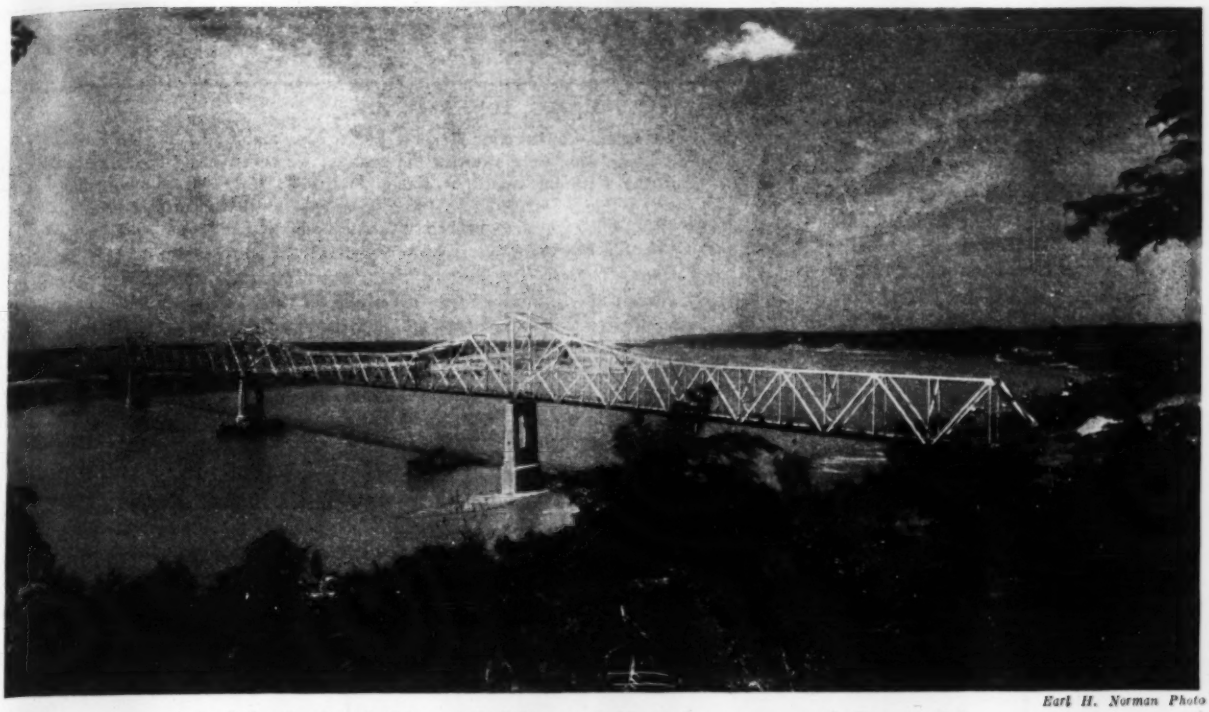
The above view shows Mount Kitchener as seen from Sunwapta Hill about 91 miles south of Jasper.

• • •

PWA not to replace roads above Grand River Dam

The Public Works Administration is not involved in the arrangements for replacing Oklahoma roads and bridges above Grand River Dam as reported in *ENR* Sept. 12, 1940, p. 319, PWA states. As understood in Washington, the plan being considered calls for a $2,000,000 program of road relocation. WPA would put up $345,000 of the cost, $358,000 of the state's federal-aid allotment would also be used, and Oklahoma would provide the remaining $1,297,000 out of its own treasury. According to federal informants, WPA and PRA have agreed to the plan, but work is held up by unwillingness of the state to contribute its share.

PWA contends that all its obligations as to road relocation were liquidated with the construction of a bridge across the Grand River completed some time ago. This contention is based upon an oral agreement between the Grand River Dam Authority and a previous state administration. Governor Phillips has never recognized this agreement and has sought, through court and military action to force PWA to provide funds by which the authority can contribute further to the relocation of roads that will be submerged.



Earl H. Norman Photo

Mississippi River Bridge at Natchez opened Sept. 26

Boasting the longest spans (875 ft.) over the Mississippi River the Natchez, Miss.-Vidalia, La. bridge opened to traffic this week is the only fixed crossing in the 150 mi. stretch between Vicksburg and Baton Rouge. River piers are founded on clay at a maximum depth of about 150 ft. below mean low water and were constructed by the Dravo Corporation of Pittsburgh.

Length of the main structure is 4205 ft. principal spans being 560 ft., 875 ft., 875 ft., 798 ft. and 560 ft. with a suspended section of 437 ft. in the first 875 ft. span. Channel clearance of 65 ft. at mean high water (119 ft. at low water) is provided over the channel. Roadway width is 24 ft. with the floor system and hangers designed for H20 loading on 9 ft. traffic lanes and the trusses for H15 loading on 12 ft. lanes.

The superstructure was erected by the Bethlehem Steel Co. using the balanced cantilever method to minimize the falsework required in one of the swiftest stretches of the Mississippi. Six major erection units were used despite the low total of 8200 tons of steel.

The bridge was designed and construction supervised by Ash-Howard-Needles & Tammen of Kansas City and New York for whom I. P. Hanson was resident engineer. Approach work was done by R. J. Reid Contracting Co. of Birmingham, Ala. and toll houses, etc. built by Forcum-James Const. Co. of Dyersburg, Tenn.

Cost of the bridge is $3,450,000 supplied from a PWA grant and an RFC loan. Approach improvements in Natchez cost $100,000 more, financed and constructed by the Mississippi highway department assisted by a 45 percent PWA grant.

Page urges continued reclamation work as part of defense program

Points out that Congress will need to increase reclamation fund or transfer money designated for larger projects

Irrigation work may aid and certainly does not conflict with the national defense, Commissioner of Reclamation Page told the National Reclamation Association this week, urging that the reclamation program not be needlessly disrupted by the defense program. Page said that power development at such projects as Boulder, Coulee, and Shasta are of immediate value to defense, that in the future supplies of food from projects may be needed, and that by stabilization of population the projects contribute to the internal strength of the country.

Page said that the Reclamation Fund is in danger of depletion—about $200,000,000 being required for completion of projects under way—and the fund will either have to be increased by Congress or some of the larger projects must be transferred to the general fund. When repayments begin from Grand Coulee and Central Valley, this problem should be relieved.

Meanwhile, the outlines of the job still facing Reclamation were described to a Congressional committee by E. B. Debler, hydraulic engineer. Debler said that of about 43,300,000 irrigable acres in the West about half—21,300,000 acres—are now under irrigation. About 4,000,000 acres of this is provided by Bureau of Reclamation projects at a total expenditure over the past 38 years of about $250,000,000. Of the remaining 22,000,000 of potentially irrigable land, nearly 7,000,000 is in the central valley of California. Cost of developing all remaining irrigable land would be about three and a quarter billions.

• • •

Marshall Ford Dam placed in service

To increase its control over the waters of the Colorado River in Texas, the Lower Colorado River Authority, on Sept. 10, closed the gates of Marshall Ford Dam. The authority plans to fill the Marshall Ford reservoir to a depth of 45 ft. by releasing water from Buchanan Lake.

Marshall Ford Dam was originally designed for a height of 193 ft. structure but is now being increased to a height of 265 ft. The power house has already been completed and installation of the first two generator units is under way.

Gascoigne firm becomes Havens and Emerson

Following the death of George B. Gascoigne Aug. 17, Gascoigne and Associates, consulting sanitary engineers of Cleveland and New York, have reorganized by formation of a partnership under the name of Havens and Emerson. Members of the new firm are: William L. Havens, Charles A. Emerson, Alfred A. Burger, Frank C. Tolles, and Frank W. Jones. The new firm will continue to maintain offices in Cleveland and New York.

Havens, following six years of service as assistant engineer in the division of sewage disposal of the city of Cleveland, joined the firm in 1922. Emerson, following 14 years of service as principal assistant engineer and chief engineer of the Pennsylvania state department of health and 13 years in private practice as an associate in the Fuller & McClintock organization, has been with the firm for the past four years in charge of the New York office.

Following work at Columbus and Akron, Ohio on hydraulic and waterworks design, Burger joined the company about 18 years ago to be placed in immediate charge of design and construction. Tolles, formerly designing engineer in the Cincinnati department of public works and superintendent of public works at Akron, Ohio, has been a member of the Gascoigne organization for 15 years, specializing in valuations, investigations and reports on water supply and sewerage projects, and Jones, after working as assistant engineer of the New York state department of health and in charge of operation of the sewage treatment plant at Fitchburg, Mass., joined the Gascoigne organization in 1932. Jones has been in charge of laboratory work and general sanitary investigation.

. . .

Indictment follows Illinois building probe

Nineteen individuals, six labor organizations, four companies and one trade association were named on charges of conspiracy to restrain trade in a sweeping anti-trust indictment returned by the East St. Louis, Ill. federal grand jury Sept. 21.

Climaxing weeks of inquiry into the building trades industry, the indictment follows clashes of rival labor unions over erection of a prefabricated house at Belleville, Ill. It charges that the defendants violated the Sherman anti-trust act by conspiring to keep certain types of construction materials out of the tri-county area of Madison, St. Clair and Monroe counties, Ill.

JOBS OF THE WEEK

TEMPORARY HOUSING, Little Rock, Ark.

MacDonald Construction Co., St. Louis, Mo., and G. L. Tarlton Contractor Inc., St. Louis, Mo., were awarded the contract for constructing the temporary housing for the National Guard at Camp Joseph T. Robinson. Construction Quartermaster, Camp Joseph T. Robinson, awarded the $4,615,920 contract.

PULP MILL, St. Marys, Ga.

Morton C. Tuttle Co., Boston, Mass., will construct a $2,000,000 pulp mill at the mouth of the St. Marys River in Georgia for the St. Marys Kraft Corp., St. Marys, Ga. George F. Hardy, New York, is architect and engineer for the project.

FLOATING DRY DOCK, Wash., D. C.

Dravo Corporation, Pittsburgh, Pa., was lowest bidder for a floating dry dock with a bid of $1,340,000. The work is being done by the Bureau of Yards & Docks, Navy Dept., Washington, D. C.

TEMPORARY HOUSING, Scott Field, (Belleville P.O.) Ill.

Dickie Construction Co., St. Louis, Mo., was awarded a $1,082,214 contract for temporary housing at Scott Field. Construction Quartermaster is doing the work.

ARMY TRAINING CAMPS, Alexandria, La.

W. Horace Williams Co., Inc., New Orleans, La. will construct the army training camp in the Bringhurst Forest Area, near Alexandria, La., for the War Department under terms of a $4,300,000 contract. E. P. Archer & Co., Kansas City, Mo., are engineers for the work. Forcum-James Co., H. N. Rodgers and S & W Construction Co., all of Memphis, Tenn., were awarded a $4,242,655 contract for an army training camp near Beaver Creek.

TRAINING CAMP, Brownwood, Tex.

Robert E. McKee, El Paso, Tex., will construct on a cost-plus-fixed-fee-basis the 36th Div. Texas National Guard training camp, which is estimated to cost $5,000,000. Quartermaster General, Washington, D. C., awarded the contract. Koch & Fowler, Dallas, are engineers for the work.

BRIDGE, Connecticut

American Bridge Co., New York, N. Y., bid low for the superstructure for a 3,950-ft. bridge over the Connecticut River between East Hartford and Hartford, Conn. Bids were asked for a rigid continuous plate girder design and a Wichert girder design with bids being $1,236,967 and $1,439,880. For the substructure the A. I. Savin Construction Co., East Hartford, bid low with bids of $672,500 and $548,982. The Connecticut State Highway Department, W. J. Cox commissioner, is doing the work.

AIRPORT, Anchorage, Alaska

Bechtel-McCone-Parsons Corp., Los Angeles, was awarded a contract on a cost-plus basis for constructing at Elmendorf Field a new airbase for the Constructing Quartermaster, Washington, D. C. Estimated cost of the work is $1,600,000.

TNT PLANT, Wilmington, Ill.

Stone & Webster Engineering Co., New York, N. Y., will design and construct, under terms of a $10,800,000 contract, a TNT plant near Wilmington, Ill., for the War Department, Washington, D. C. E. I. duPont de Nemours & Co. will operate the plant and supervise installation of the equipment. Total cost of the project is estimated at $14,000,000.

AVIATION FACILITIES, Panama Canal

Lindgren & Swinerton, San Francisco, Calif., Hegeman-Harris, Inc., New York, and Tucker-McClure, Balboa, C. Z., were awarded a joint contract for providing additional aviation facilities at Coco Solo, Balboa, Gatum and Summit. Estimated cost of the work, which is being done for the Bureau of Yards and Docks, Navy Department, Washington, D. C., is $6,320,500.

SHIPBUILDING PLANT, Orange, Tex.

Betchel-McCone-Parsons Corp., Los Angeles, will construct at an estimated cost of $5,000,000 a shipbuilding plant and yard addition for the Consolidated Steel Corp., Ltd., Orange, Tex.

ELEVATED PARKWAY, Brooklyn, N. Y.

American Bridge Co., New York, N. Y., was low bidder for an elevated parkway in the Borough of Brooklyn, New York City, on Hamilton Ave. from Clinton St. to 2nd and 3rd avenues and from 20 St. to 36 St. The Triborough Bridge Authority, Randall's Island, is doing the work and Madigan-Hyland, Long Island City, N. Y., are engineers for the project, which will provide the connection between the Battery-Brooklyn tunnel and the Belt Parkway.

NOTE—Additional bidding and contract news on over 600 projects, large and small, appear in the Construction News Section beginning on page 108.

New awards bring total for defense plants to $300,000,000

Explosives plant and four shipyard jobs added last week. All plants are to be privately operated

The program of government-owned arms and munitions plants gained added momentum last week with the award of a contract to Stone & Webster to build a $10,863,000 TNT and DNT plant, later to be operated by duPont. Four shipyards also received contracts to build government-owned shipbuilding facilities totaling $12,950,000 These awards bring to about $300,000,000 the volume of government plant work which is either under contract or definitely assigned with preliminary operations underway.

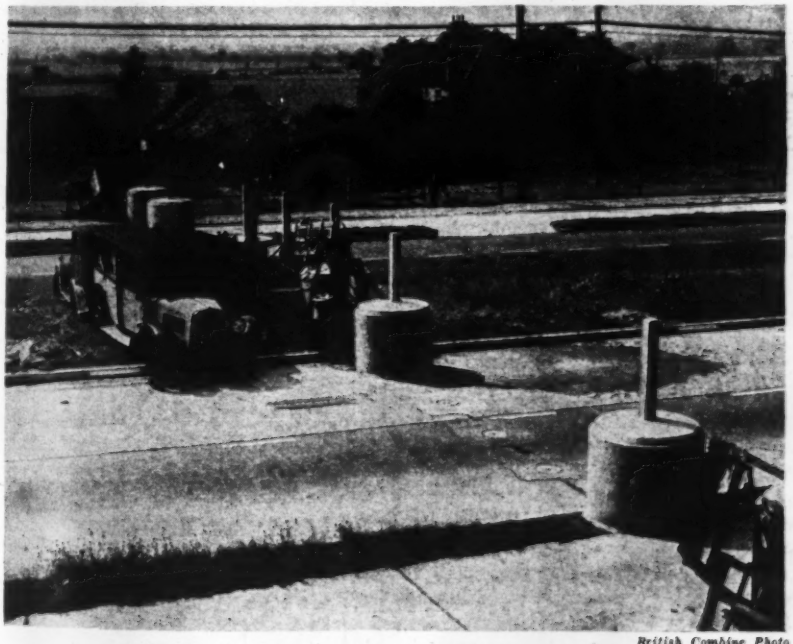
These plants are coming through under several different arrangments with the only common feature the fact that they are all privately operated. The largest number are financed out of appropriations directly allocated to plant construction; here the government hires someone to build a plant and then someone, usually the same firm, to operate it on a rental or fee basis.

Plants under way, contracts not signed

DuPont	bag-loading plant
DuPont	ammonia plant
DuPont	tetryl plant
DuPont	TNT plant
Hercules Powder	bag-loading plant
Western Cartridge	small arms ammunition
Remington Arms	small arms ammunition
Atlas Powder	TNT plant
Humble Oil Co.	toluol plant
Allied Chem. & Dye	ammonia plant

Defense plants for which contracts have been let

FIRM	TYPE OF PLANT	LOCATION	AMOUNT
Atlas Powder	loading plant	Ravenna, O.	$14,215,000
Hercules Powder	smokeless powder	Radford, Va.	25,000,000
	(this will be enlarged under a pending change order)		
DuPont	smokeless powder	Charlestown, Ind.	25,000,000
	(this will be enlarged under a pending change order)		
Stone & Webster	TNT	Wilmington, Ill.	10,863,000
	(DuPont will operate this)		
Savage Arms	machine gun	Utica, N. Y.	17,600,000
General Motors	machine gun	several locations	20,000,000
Chrysler	tank	Detroit	25,000,000
Carnegie-Illinois	Navy guns	Pittsburgh	2,275,000
Packard	engines	Detroit	
Consolidated Steel Co.	shipbuilding	Orange, Texas	4,600,000
Seattle Tacoma Shipbuiding	shipbuilding	Seattle	4,600,000
Manitowoc Shipbuilding	shipbuilding	Manitowoc, Wis.	1,000,000
Electric Boat Co.	shipbuilding	Groton, Conn.	2,750,000
Sanderson & Porter	ammunition loading plant	Wilmington, Ill.	14,000,000



British Combine Photo

Traffic bottleneck in southern England

One of England's present problems is to maintain traffic as usual but to be ready to obstruct the roads if the country is invaded. Precast concrete pipe has been used extensively, filled with concrete and placed as barriers anchored into the ground. Provision is made for quickly placing additional blocks in the roadway.

Caption released by censor states that anti-tank traps are at the side of the road.

WASHINGTON HIGHLIGHTS

Under the terms of a bill reported favorably to the Senate last week, bridge replacement procedure in the TVA area would be made to conform to the new policy on replacement of bridges over navigable waters adopted by Congress this session. The bill would authorize the TVA to pay the cost of alterations to bridges necessitated by its reservoir construction, charging the owner only for the direct benefit to him. Immediately affected would be $2,000,000 to $3,000,000 worth of replacement work in Kentucky, Watts Bar and Coulter Shoals reservoirs.

HOUSING of conscripts, the War Department announced this week, will require the construction of sixteen large cantonments for regular army and national guard units and twenty-one smaller cantonments which will serve as replacements centers for conscripts waiting assignment to army and guard units. In addition twelve large camps will be built for the National Guard and two small cantonments and four small camps for anti-aircraft training centers. New air stations are to be established at thirty civil airfields. In order to expedite provision of barracks for conscripts, Congress last week passed a special bill appropriating $338,264,000 for the purpose—$8,744,000 for purchase of land and the rest for construction. This money was originally included in the third supplemental defense appropriation, now pending (*ENR* Sept. 19, 1940, p. 373), but special haste is needed for the barracks program.

BRIEF NEWS

NORTH CAROLINA officials have requested the U. S. Engineers to make a survey of flood control needs in that state with a view of placing the Roanoke, Yadkin and Tuckasigee rivers on the army flood control list. The three streams are among those which recently damaged roads of that state so heavily.

THE NEW TOLL highway bridge across the Mississippi River at Greenville, Miss., was dedicated Sept. 17. Built at a cost of $4,500,000 by the city of Greenville the cantilever structure consists of a main span of 840 ft. and two 640 ft. anchor spans. Tolls for the bridge will be $1 per automobile and 20 cents for passengers other than the driver. The structure will not be opened to traffic until October, when the approach road on the Arkansas side will be completed.

OBITUARY

GEORGE G. EARL, 76, general superintendent of the New Orleans sewerage and water board from 1900 until his retirement in 1931 and consultant of that body since that time, died in New Orleans Sept. 16. Following his graduation from Lafayette College in 1883 he worked as division engineer for the Chicago, Santa Fe and California R.R. Later he worked as assistant engineer on sewage construction for the city of Montgomery, Ala. and still later was city engineer of Americus, Ga. In 1892 he became chief engineer of the New Orleans Sewerage Co. which prepared surveys, designs and estimates for the New Orleans sewage system. He was president of the American Water Works Association in 1915 and in 1926 was made an honorary member.

ALEXANDER C. CODET, 60, assistant director of the bureau of construction of the department of public works of New York City, died Sept. 21 at Munsey Park, L. I.

ARTHUR C. WATSON, 59, chief engineer of the Long Island R.R. and of the New York zone of the Pennsylvania R.R., died Sept. 23 in New York City. Following his graduation from Washington and Jefferson College in 1902, he soon joined the Pennsylvania R.R. on its lines west of Pittsburgh. Advancing through the posts of assistant division engineer, division engineer and superintendent, he was made chief engineer of the Long Island system in 1927.

J. Y. WILSON, 70, state director in Florida of operations for the Work Projects Administration, died recently at Jacksonville, Fla. Wilson had been a contractor in Jacksonville for 18 years prior to joining the CWA as staff engineer. Later he was appointed director of operations for the FERA and in 1939 was named Jacksonville state director for the WPA. For a number of years he was also employed by the U. S. Engineers at St. Augustine, Fla.

CHARLES F. UEBELACHER, 72, former chairman of the board of directors of Ford, Bacon & Davis, Inc., New York, died Sept. 17 in Newark, N. J. He had acted as engineer for utilities in Pittsburgh, Chicago, San Francisco and New York and as a consulting engineer and chief technical adviser on the construction of smokeless powder plants in Virginia and Tennessee during the World War. He was a graduate of Princeton University.

LEWIS B. SHURTLEFF, 54, commissioner of public works of the city of Syracuse, N. Y., died in that city Sept. 18.

ARTHUR J. GRANFIELD, 58, San Francisco contractor and president of Granfield, Farrar & Carlin, excavating and grading contractors, died recently.

ROBERT A. BALDWIN, 65, former construction and civil engineer with the Canadian National Railways, died Sept. 9 in Toronto, Ont. Following his graduation from the University of Toronto, he joined the Canadian Northern Ry. to continue with that line upon its amalgamation with the Canadian National Railways.

WILLIAM J. GALLAGHER, 75, retired engineer formerly with Jones & Laughlin Steel Corp. and for 50 years construction engineer on the Monongahela Connecting Ry., died Sept. 11 in Pittsburgh.

CONTRACTS AND CAPITAL

FOR the second successive week, and for the fourth time this year, engineering construction awards passed the $100,000,000 mark. Defense awards for military housing, government-owned munition plants and arsenals, as well as increased industrial building volume bring the week's total to $102,177,000, 135 per cent higher than in the corresponding 1939 week, but 15 per cent below last week's high volume.

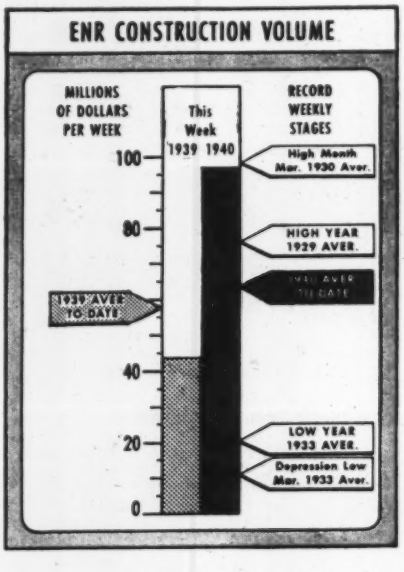
Private awards are up 91 per cent compared with last year, and 7 per cent above last week. Public construction tops a year ago by 158 per cent, but is 22 per cent under a week ago.

The construction total for the year to date, $2,502,973,000, exceeds the $2,265,252,000 reported for the 39-week period in 1939 by 10½ per cent. Private construction is 22 per cent higher than a year ago, and public awards are 6 per cent above last year due to a 176 per cent gain in federal work.

Industrial buildings reached the second highest volume of the year as a result of almost $17,000,000 for five large project awards in Texas, Georgia, Pennsylvania and Wisconsin. In addition to industrial buildings, waterworks and sewerage top their last week's totals; and waterworks, sewerage, commercial and public buildings, earthwork and drainage, and streets and roads exceed their 1939-week volumes.

New capital for construction purposes for the week totals $309,946,000. This compares with $8,856,000 for the corresponding 1939 week. The current week's financing is made up of $294,655,000 in federal funds for defense construction; $7,392,000 in USHA loans, $7,316,000 in state and municipal bonds, and $583,000 in corporate security issues.

The revised new construction capital figure for the 39 weeks of 1940 totals $2,847,467,000, a 31 per cent increase over a year ago.



CONTRACTS

(Thousands of dollars)

	Week Ending Sept. 28 1939	Sept. 19 1940	Sept. 26 1940
Federal	$2,694	$52,275	$42,029
State & Municipal	25,880	41,848	31,664
Total public...	$28,574	$94,123	$73,684
Total private..	14,937	26,686	28,493
TOTALS	$43,511	$120,809	$102,177
Cumulative 1940 ....(39 weeks)....			$2,502,973
1939 ....(39 weeks)....			$2,265,252

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	1939 39 Wks.	Cumulative 1940 39 Wks.
NON-FEDERAL ..	$1,050,924	$1,174,240†
Corp. Securities.	181,404	201,533
State & Mun....	412,797	372,647†
R.E.A. loans....	89,445	40,000
U.S.H.A. loans..	172,963	180,465
R.F.C. loans....	4,315	195,595
Fed. Aid-Hwy...	190,000	184,000
FEDERAL	1,128,028	1,673,227
TOTAL CAPITAL.	$2,178,952	$2,847,467†

† Revised to eliminate duplication in short-term financing for U.S.H.A. projects.

FHA MORTGAGES

	Week Ending Sept. 23 1939	Sept. 14 1940	Sept. 21 1940
Selected for appraisal	$22,649	$28,179	$29,270*
Cumulative 1940 .....(38 weeks)....			$956,924*
1939 .....(38 weeks)....			$851,365

* Subject to revision.

ENR INDEX NUMBERS

			Index Base = 100	1913	1926
Construction Cost	Sept.,	'40..	244.13	117.35	
Building Cost	Sept.,	'40..	203.13	109.85	
Volume	Aug.,	'40..	281	123	

Road officials meet

(*Continued from p. 27*)

several state highway organizations, he said, would utilize well-equipped, experienced men in construction and maintenance of roads to carry on a highway improvement program without the confusion and uncertainty which has been experienced in some of our national defense moves. Of the 75,000 mi. of strategically important highways, 20,000 mi. do not come up to military standards, and likewise there are some 2000 substandard bridges. In allocating funds for the correction of this situation, there is need for priority to eliminate the serious bottlenecks first. The Pacific Highway, he said, is a strategic route of great importance yet, in part, it "is wholly inadequate to the needs of national defense and no modern army could negotiate it." This, like many other routes, should not be brought up to military standards with state funds. While peacetime requirements would justify a state in meeting 15 to 25 per cent of the cost of improving such routes, the other 75 to 85 per cent should come from federal funds because the strategic military value is a national matter.

Penn Turnpike praised

After describing Pennsylvania's new 160-mile turnpike between Harrisburg and Pittsburgh, Samuel W. Marshall, its chief engineer, said a battalion of 155's, on a recent military maneuver, had occasion to use the turnpike as well as public highways. "The comparison was astounding—25 mph of hazardous running on public roads and 50 mph of easy travel on the turnpike," he reported. He looks forward to a network of similar highways throughout the United States, partly for military reasons and partly because only with such routes can roadbuilders "catch up with the development of automobiles and the actual requirements of the motoring public".

The European war should be a lesson to us on the essential part which highways would play in any major attempt to invade North America, according to a paper by A. W. Brandt, superintendent of public works of the state of New York, which was read by David Noonan, assistant state highway commissioner. "The German super-highway system," he said, "permitted the lightning movement of the Nazi motorized and mechanized equipment, and in contrast with this the congestion which occurred in Belgium and Holland, when forward-moving military equipment encountered streams of refugees moving back from the battle zone, made impossible the efficient operation of the defending armies". Measures he recommended for this country are, first, to remedy the deficiencies in the existing system, particularly the strengthening of "weak links" in inadequate bridges, and then to construct vitally necessary bypasses around cities.

MacDonald discusses defense roads

Grave necessity now presses for national understanding of defense highways, said Thos. H. MacDonald, commissioner, U. S. Public Roads Administration. State-wide planning surveys of the past two or three years provide highly useful information, and policies affecting the defense highway program as a whole will be worked out by members of a highway transport committee of the A.A.S.H.O. Appointment of a committee for this purpose has been authorized by John M. Carmody, administrator, Federal Works Agency.

It is now certain, MacDonald said, that important changes are facing us in the use of our highways. The extent will depend on the tempo of wars in other countries. "But we can be sure," he said, "of new characteristics as part of the daily life on our highways, including troops on the march, transport trucks, motorized ordnance, increased local movement of automobiles and trucks around production plants, the highway traffic incident to training camps and a step-up of miscellaneous highway traffic". To provide highways for this traffic, the proper conception, according to MacDonald, is not the exact roads as outlined on the basic map, but rather of routes which will very likely consist ultimately of several roughly parallel roads, depending upon the particular section of the country in which they are located and the possible service requirements to which they will be subjected.

Many bridges need strengthening

Structural requirements incidental to these military activities will be met, he said, by H-15 specification loadings. Some idea of the necessary program ahead is given by the fact that of the 16,000 rural bridges on the strategic network, some 1800 have capacities less than H-15 specifications. A large mileage of road surfaces will need to be strengthened, perhaps as much as 14,000 mi., and in rural highways a most apparent general lack (from the military viewpoint) is the too-narrow shoulder widths. In referring to the new highway legislation, MacDonald pointed out that authority is granted to use federal aid funds apportioned to the states for engineering work required, including construction engineering if the state is unable for any cause to carry the costs. For roads of the strategic rural network, however, federal aid funds will probably not be approved for project engineering.

A report on the adequacy of our highways for national defense is now being made, MacDonald said, under direction of the Federal Works Agency in cooperation with the War Department, the Navy Department and the Defense Advisory Commission. A.A.S.H.O. members are cooperating in assembly of the data, and the report should be ready in about 30 days.

J. G. Brennan, engineer of the American Association of Railroads, Washington, D. C., emphasized the menace that arises from more than 230,000 railway-highway grade crossings on first-class railroads alone. Grade crossing elimination is lagging badly behind general federal aid programs, he said, despite the urgent need of the railroads for protection from motor vehicles. Last year more than 35 per cent of the grade crossing accidents resulted from autos running into the sides of trains. Financing grade crossing improvements is largely a responsibility of state and federal governments, railroads usually being required to pay up to about 15 per cent of basic costs.

The new officers

Officers elected for the ensuing year include: President, J. S. Williamson, South Carolina; vice-presidents, E. B. Whitman, Maryland; C. J. Sherlock, Alabama; E. L. Roettiger, Wisconsin; and R. L. Bobbitt, Texas; Treasurer, G. H. Henderson, Rhode Island; executive committee members, A. W. Brandt, New York; C. W. Brown, Missouri; and T. H. Cutler, Kentucky. W. C. Markham is the veteran executive secretary of the association.

On the afternoon of the third day of the convention, at the end of a paper on the Lake Washington Pontoon Bridge by Charles E. Andrew, principal consulting engineer, Washington Toll Bridge Authority, the delegates were taken out to inspect that structure. The afternoon of the fourth day was devoted to an inspection of the Tacoma Narrows Bridge which has a 2800-ft. suspension span.

. . .

Costa Rica gets loan for Inter-American road

Following out the policy of using Latin American loans to strengthen hemisphere defenses, the Export Import Bank, an RFC subsidiary, has loaned $4,600,000 to Costa Rica to be used in improving the Costa Rican section of the Inter-American highway. About 60 per cent of this amount, it is announced, will be used for purchase of road equipment in this country. The loan will be repaid over a 10-year period from the proceeds of a gasoline tax.

At present, of the 350 miles in the Costa Rican section of the highway, only about 60 miles is passable in all weather, and most of the highway is at present a mere trail.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Keeping Cities Together

Sir: In the article, *Replanning Our Cities for Living*, by Emerson Goble (*ENR*, Aug. 15, 1940, p. 231), the author blames the automobile for decentralization of American cities and briefly mentions a few current notions for stopping this proceeding, all of which he rejects. I daresay that decentralization started before the first human community got under way and the process was extended to every community since the institution of private ownership of property was first accepted. Decentralization took a spurt forward during the horse and buggy days but the greatest acceleration was given by the greater flexibility of the bus and private automobile.

Decentralization is one of those modern streamlined words which was coined to describe the operation of a rather old law of economics—the law of rent. This law of rent is probably the most interesting of the laws of economics and it is inexorable in its operation. It is a result of the increase and expansion of population and of human endeavor and has no more to do with the automobile than the ox cart. The automobile merely has exaggerated the effect of the operation of this law.

Briefly stated, the rent of land is determined by the excess of its produce over that which the same application can secure from the margin (least productive land in use). This formulation of the law does not merely apply to agricultural production but to production in all its forms, as well as to the desirability of location for residential purposes. Whatever one is willing to pay for the use of a site rather than use free marginal land is rent.

The effect of increasing population upon the distribution of wealth is to increase rent and consequently to diminish the proportion of the produce which goes to capital and labor. Applying this to residences, a house on a plot of land in the heart of a city would entail a greater rent than an identical house on marginal lands. Here one must weigh the advantages and convenience of living in the city against the inconvenience of living in the suburbs. From the effects of the present rate of decentralization, one must conclude that the bus and the private automobile are the balancing agents in the equation. Because of the high land rent of city lots, one can achieve cheapness of living only by distributing this rent amongst numerous families all living on one plot and then we have the modern cliff dwelling which we call an apartment house.

This in brief is the cause and effect of the law of rent and decentralization and there is not much that can be done about it and still remain orthodox. The author mentions that one of the major difficulties housing authorities have faced lies in the high land values in blighted districts. Such lands can be owned only by wealthy individuals or corporations who are willing to pay the annual taxes and sacrifice the interest on their investments while waiting and hoping for a further rise in land values.

The author mentions several proposed remedies and seems to reject them. Arbitrary fixing of land values, condemnation under eminent domain and government loans which amount to subsidies are all wrong and unjust. The least justifiable remedy, that of taxing suburbanites who earn their living in the city and do their spending outside, is now practised by some bankrupt or nearly bankrupt cities.

Unquestionably, the author is correct in his statement, "It will require the assimilation of some new concepts of engineering and economics and even of property rights." Probably the most brilliant solution to the problem that has ever been given to humanity lies in the political-economic philosophy of Henry George as written in his "Progress and Poverty." Briefly his thesis is this: Cast aside our entire present system of taxation and raise taxes for all purposes by taxing completely all rent on land but not on the improvements on land.

There are many aspects of this question which cannot be treated here. The solution advanced, however, is tantamount to the abolition of private proverty in land. A landowner would still hold the title to his land but the full rent would be paid to the state and, owing to the nature of the law of rent, he could not pass this tax to his tenants. One consequence of this proposal would be a quick determination of the real value of land. Those who hold land for speculation, whether in blighted areas or in the suburbs, would be forced to put their property to full utility or disgorge and turn it over to those who could use it.

Decentralization would not be halted because that is a matter of population increase, but zoning could then be made a real institution based on proper planning instead of the present selfish purposes.

ERNEST H. HARDER
East Orange, N. J.

Engineering Council

Sir: The discussion of the engineering profession, centered at the moment in American Engineering Council, is becoming very interesting. If it leads up to the asking and answering of the following questions concerning A.E.C. it will be worth while:

(1) What authority and responsibility does A.E.C. have?

(2) What representation on A.E.C. is there for the members of the engineering bodies?

(3) Who pays the "taxes" to support the body?

At the present moment, I believe most engineers fear that the answers to these questions must be made with less of logic and more of expediency. You will find, for instance, that the leading member-bodies supporting A.E.C. do not provide for it in their constitutions. They simply say, if they say anything at all, "The society shall be represented on American Engineering Council . . ." The Council has its own constitution, which is not embodied in the fundamental documents of the supporting societies.

In the minds of many, the basic questions of authority, responsibility, representation, and taxation, apply to all the joint engineering bodies today, and to many of the autonomous societies too. In other words, the engineering-profession set-up is adjudged by some as a series of pub-

licity and propaganda bodies, with taxation (dues) correlated to representation as little as necessary.

The engineering profession exists and flourishes. The societies activated by the field draw a great deal from the "engineering-profession idea" and some of them make valuable reimbursements. Discussions such as this one of American Engineering Council are simply evidences that many real professional engineers seek to make reimbursements more commensurate. But the rank and file of engineers do not sense the obligation particularly, or else are befuddled by the complexities. Hence the societies are more and more put to it to conserve and develop the interest of their members at large.

To show how the societies try this eagerly, one need only mention their new interest in the national defense emergency. The bodies have no authority or responsibility in the program now being crystallized.

The engineering profession has its place in the community. This place is well understood in public opinion. The public senses the profession at its best in an advisory capacity, knowing full well that in this country and at this time the profession is subordinate to government. The leaders of the profession are justified in not accepting this condition, and in seeking to improve it, in advocating that the profession seek authority, responsibility, and representation. But to get over this hurdle, it would seem that the societies need to agree on a czar, a dictator, and this they are not in the mood to do.

For most engineers, the situation may develop enough intensity to force something like this. Some leading society, like the American Society of Civil Engineers, may find itself forced to take the leadership. Engineering Council could take it, but not so easily. The Am. Soc. C.E. has the makings to produce and support a man who could become the link between what the public thinks the engineering profession is and what the engineering bodies know it is. What would such a man do primarily?

His main job would be to help suggest policies to the numerous engineering societies *so that their members stay association-minded.* With the maximum number of engineers association-minded, all the societies could spend much less time and money on justifying their existence, and on worrying about what the public thinks about the engineering profession and its utility.

It is obvious to any thinking engineer that the current discussion of American Engineering Council is all along the lines of trying to justify the existence of the body. Such a tone cannot help but impress some engineers that the body has died already. Of course it has not died, as it never existed except as a spirit, with as little corporeal body as necessary to interest engineers in contributing financial nourishment. Yet, as a spirit, Council is invaluable. Does it not at times find unique opportunity to speak for the engineering profession?

WILLIAM E. BULLOCK
New York, N. Y.

Vehicle Tunnel Lighting

Sir: Assuming that at this late date some useful purpose may be served by further discussion of Mr. Dodds' comment (*ENR*, Dec. 21, 1939, p. 813) on my article on the lighting of vehicle tunnels (Aug. 31, 1939, p. 49), I would like to add the following:

Admittedly, there are many influencing factors entering into the equation of "visibility through a traffic tunnel" other than the level of illumination on the pavement expressed in terms of foot-candles. The same statement holds true in the case of visibility along an open highway, or even of seeing ability in an office. The fact remains, however, that this factor of average illumination over the pavement remains as the one most descriptive and most universally recognized "measuring stick" of the resulting ability to see.

Since the illumination of traffic tunnels deals, primarily, with providing adequate protective visibility in terms of moving vehicles, the experience gained in street and highway illumination should be extremely useful in effectively solving these tunnel lighting problems. Obviously, tunnel illumination is not called upon to meet the many exacting demands of interior lighting, where discernment of fine detail in continuous application, minimizing of eye fatigue from both light source and reflecting surface brightness and true color discrimination are some of the major considerations.

The average illumination over the Lincoln Tunnel pavement is 1.3 foot-candles. Incandescent luminaires on relatively close spacings—one unit to each 10 ft. of tunnel provide a uniformity of light distribution over the pavement (maximum to minimum foot-candles (of approximately 1.4 to 1; at an energy consumption of 15 watts per linear foot of pavement. The sodium illumination in the Liberty Tunnel produces a measured level of 2.5 foot-candles over the pavement; a uniformity in light distribution of 2.3 to 1, and an energy consumption of only 5 watts per linear foot of pavement. These sodium light sources are spaced some 50 ft. apart over the roadway. Many qualified observers prefer the visibility in the sodium-lighted Pittsburgh tube to the incandescent illumination in the Lincoln Tunnel.

Relative to the problem of supplementary tunnel entrance lighting during the daytime, while 8,000 to 10,000 foot-candles in direct sunlight have been measured under most favorable conditions, it must be remembered that the average daytime illumination during the year in this latitude is more nearly 2,500 foot-candles than 8,000. Again, the physical direction of the tunnel bore, plus such other influencing factors as buildings, foliage and hillsides conveniently adjacent to the tunnel portal have a very direct bearing upon the intensity of artificial illumination immediately inside the portal necessary to eliminate the hazardous loss of visibility of a motorist entering the portal during the daytime.

The following tunnels are now equipped—or are being equipped—with supplementary entrance illumination for daytime burning: Tooth Rock Highway Tunnel, Oregon; Salt Creek Tunnel, Oregon; McCallie Avenue Tunnel, Chattanooga; Liberty Tunnel, Pittsburgh; Midtown Tunnel, New York; Pennsylvania Turnpike tunnels, Pittsburgh-Harrisburg.

Undoubtedly, more is still to be learned about the most effective and economical methods of tunnel illumination; the writer is firmly convinced that illuminating engineers who are thoroughly versed in the principles and practice of street and highway illumination are the best qualified to make further contributions to this practice of tunnel illumination.

R. M. SWETLAND
Illuminating Lab., General Electric Co., Schenectady, N. Y.

EDITORIALS

VOLUME 125 NUMBER 13

September 26, 1940

Landmark Saved

IT IS WELCOME NEWS to learn that Chicago's Dearborn St. landmark, the Monadnock Block, is being saved from the risk of undermining by the new subway. This historic structure, a relic of the early days of skyscraper building, is additionally distinguished by being wall-bearing in its earlier half, built after cage construction was already established, half a century ago. Thus it is one of the surviving examples of the genesis of modern building. Tunneling many feet below its foundations threatened its stability, however, and, since its foundation grillages projecting far out into the street interfered with the proposed subway station, a heroic underpinning operation was necessary, as described this week. The significance of the operation will be clear to anyone who has observed the subsidence that develops near excavations in the Chicago clay. The inevitable loss of ground in excavation redistributes the soil stresses and causes the ground surface to dish sufficiently to endanger a high, narrow building of great weight. Underpinning to forestall settlement will also reduce the likelihood that flow of the subsoil might cause injurious lateral displacement.

Famous Road Replaced

STORM KING HIGHWAY, widely acclaimed nearly twenty years ago for its bold and spectacular design and construction, has been replaced by a new highway designed to meet present-day requirements for speed and safety. The old highway for a large part of its length was on a shelf cut from the steep face of Storm King Mountain, high above the Hudson River near West Point. Although its 24-ft. roadway with 18 ft. of bituminous paving was characterized as a modern highway when it was opened, rock slides were always a source of danger and, when modern car speeds added a new danger at the sharp curves, the need for a new road became compelling. This new road has been built much farther back from the river, but because it has to climb to an elevation of over 1,200 ft. to get satisfactory grades and alignment, it is not lacking in magnificent views down into the river valley. A four-lane divided highway, with curves and sight distances ample for driving at high speed, it adequately measures up to the standards of the present. That twice as much was spent in building this road as was spent on the old one is indicative of the continuing cost of highway modernization. And with this example before us we would be lacking in vision if we were to say that relocation or reconstruction may not again be called for in 1960.

Flexibility in Sewage Disposal

HOW TO PROVIDE adequate and economical sewage disposal facilities in resort communities, where summer population increases may create a load ten times greater than normal, calls for real ingenuity. Two recent examples of treatment plant design to meet this difficult problem are described in this issue. At Liberty, N. Y., the solution was found to lie in the use of the biofiltration process; filters designed to handle high rates of flow during the summer period are readily adapted to standard trickling-filter operation during the nine months of small load. In the Iowa lakes region an activated sludge plant with dual treatment units—one for winter operation and both for use in the summer period—was the answer. These examples prove that the sanitary engineer is rapidly developing the means to cope with one of his most difficult problems—wide disparity between average and peak loads.

Better Steel Painting

WITHIN THE PAST HALF DOZEN YEARS some 50,000 tons of structural steel have been cleaned by oxy-acetylene flame prior to painting. The popularity of this method and the widespread interest shown in perfecting it bid fair to inaugurate an improvement in structure painting that will rival that which has occurred in the painting of automobiles. But it is important to note that there are significant differences between painting cars and painting bridges. Both are made of steel, and both can utilize the new and more durable paints that have been developed, but the automobile steel can be prepared for painting under controlled conditions of heat and humidity that have not been available for structural steel. The use of the oxy-acetylene flame, however, changes the situation. And not only does the flame dry the surface but the heat

is applied so rapidly that non-adhering scale is broken down as the scale itself expands and as the moisture beneath it is expanded into steam. After brushing, a warm, dry, clean surface, universally recognized as ideal for painting, is presented. Flame cleaning technique and tools are reasonably well established, as outlined elsewhere in this issue. Also every job offers opportunity for further experiment and improvement. And as advantages are established and limitations set, flame cleaning can assume its proper place with sandblasting, chipping and scraping (over which it can offer a warm dry surface) as a means of preparing structural steel for painting.

Strength in Organization

WHEN THE 12-year-old Federation of Sewage Works Associations meets for the first time in a convention next week, a plan will be presented for the formation of a national association to unify and broaden the activities of 25 existing local, state and district groups. Because this desire for centralization of organization comes at a time when the trend in national societies is toward decentralization, the plan is of especial interest.

There is much to be said in favor of maintaining strong local organizations, the activities of which can best serve the needs of the individual. On the other hand, local groups can be most constructive in their professional efforts when they are knit together in a manner that makes exchange of experience and concerted action practicable and easy.

The Federation, as it was first established and now exists, enjoys the benefits of local union but lacks the essential authority and internal organization to make its activities have national import. Its reorganization to give national voice and direction to the objectives of workers in the field of sewage disposal would therefore seem to be in accord with the needs of the times. Properly integrated, the efforts of the 2,800 members of the Federation can do much in the way of advancing policies, establishing standards of practice and equipment design and otherwise unifying all those activities which contribute to the progress of sewage disposal.

Road Program Reoriented

ANY DOUBT about the reality of the part that must be played by roadbuilding in the defense program was dispelled by Thomas H. MacDonald's inspiring statement to the Association of State Highway Officials at Seattle last week. He made it clear that transportation is a prime essential of military service, and that highways have as important a relation to defense as they do to civil life.

Fundamentally the requirements of road construction are the same for war as for peace service, but they are many times more exacting in time of war. The traffic jam that under ordinary conditions is merely an irritating inconvenience becomes in wartime a critical defect and may be a source of disaster. The undeveloped shoulders that annoy and endanger civilian transportation may lead to catastrophe when they throttle and block the movement of a military train. The lack of multiple roads between points in heavy traffic areas that merely reduces peacetime transportation efficiency may cause complete failure of a military maneuver. Our road system therefore, however efficiently planned, is inadequate for defense uses until its weaknesses are corrected.

A new orientation of highway policy was in effect outlined by Commissioner MacDonald's address. It involves not alone the study and revision of routes in the light of measured traffic requirements but also thorough attention to safe and adequate details. Substandard bridges, deficient or absent shoulders, bottlenecks of many kinds, require remedy. To relieve local congestion on main routes, multiple parallel roads may have to be developed.

In brief, defense roads are not roads designed and built for specific military use but roads adequate to provide free intercommunication and hence serve industry to fullest extent. Stated in other terms, the road system most valuable in war is the one most valuable in time of peace. The compelling test of war service, in orienting the highway program with a precision heretofore undreamed of, confronts our able state highway organizations and the federal Public Roads Administration with the need for a new and higher type of cooperation. Its results are certain to be of lasting value.

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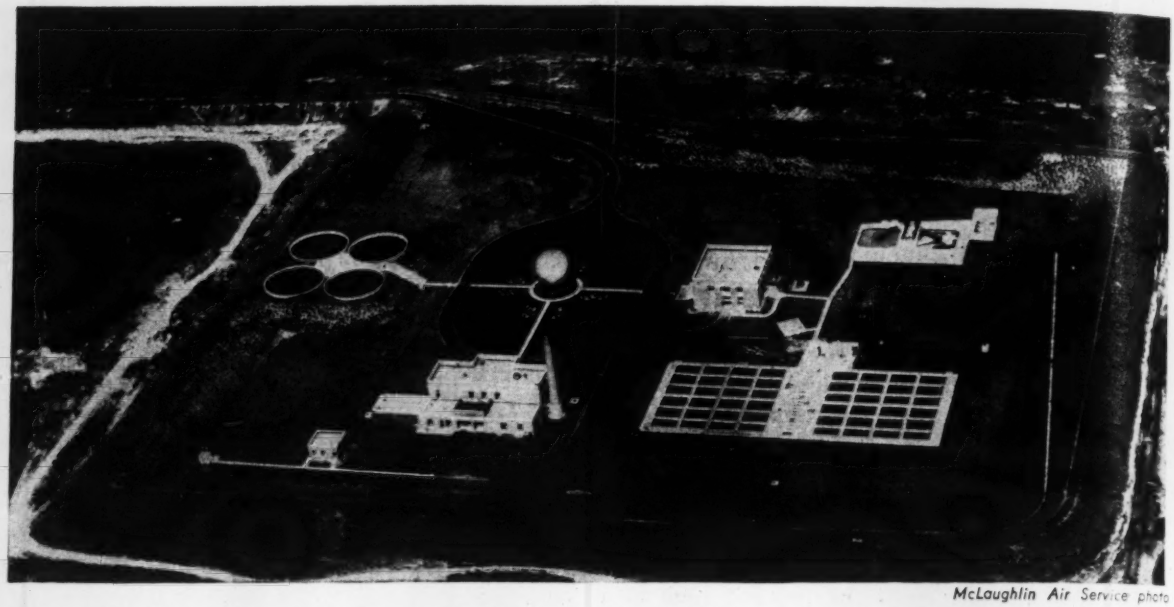


McLaughlin Air Service photo

Fig. 1. Built within a dike and tied down with 2,500 piles, the Springfield disposal plant will be immune to flood dangers.

New England's Newest Sewage Works

Edward J. Cleary
Associate Editor, Engineering News-Record

***Contents in Brief**—Notable additions to pollution abatement projects in the Connecticut River Valley are two disposal plants just placed in operation by Springfield, Mass. Particular interest attaches to the larger plant of 30-mgd capacity, where special emphasis is placed on sludge processing. This plant and a 3-mgd treatment unit are distinguished also by their architecture and landscaping.*

PROOF OF THE ASSERTION that sludge disposal is the biggest problem in sewage treatment is given demonstration at the new Springfield works, where facilities for sludge processing dominate the plant in size and cost. Treatment of the sewage was relatively simple, requiring only grit removal and sedimentation. But adequate handling of the sludge byproduct was a complex matter which required digestion and elutriation tanks, vacuum filters and incineration equipment. Further, the collection of sludge gas, which was used for heating and incinerator auxiliary fuel, called for the installation of a pressure storage tank as well as metering and control facilities.

Distinguished by cleancut functional and architectural design, the Springfield treatment works incorporate a number of special features that command attention. Chief among these are the sludge processing facilities, the manner of handling grit and screenings, and the location of the plant in the diked area where it is isolated from river floods.

Two plants have been built in Springfield and they went into operation in August. Both plants provide primary treatment, and they are major units in the plan to eliminate pollution in the Connecticut River. The largest plant, called the Main Treatment Works, has a capacity of 30 mgd.

The 3-mgd Indian Orchard plant serves an area of the city drained by the Chicopee River, a tributary to the Connecticut. This smaller plant, located in the residential area, employs primary treatment, sludge digestion and sludge drying on glass-inclosed sand beds.

Architecturally, the plant structures are featured by the extensive use of aluminum metal for windows, doors, stair railings, gratings and exterior embellishments. The steel frame buildings are inclosed by brick trimmed with limestone, and the interior walls are faced with buff tile. Landscaping of the grounds with trees and shrubs, and the establishment of lawns was completed prior to starting operations, so that both plants present an unusually attractive appearance.

The following article concerns itself with some of the special features of the plants. Design and capacity details are summarized in tabular form for quick reference.

Dikes and drainage

The main treatment plant, on the west side of the Connecticut River, is surrounded by an earth dike 3 ft. higher than previous record flood

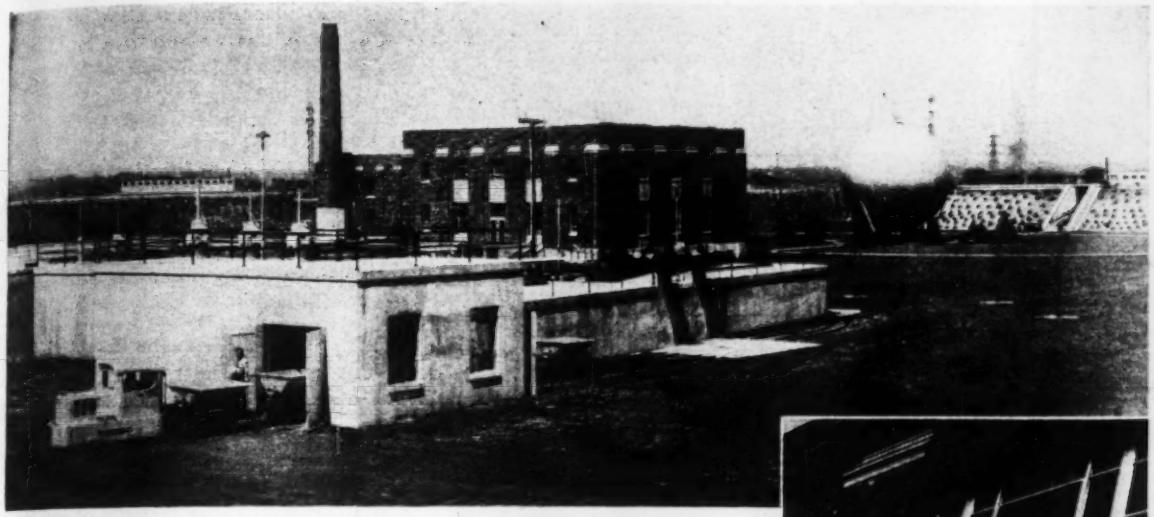


Fig. 2. Grit removal facilities are elevated above ground, and the washed grit is discharged by gravity into dump cars. In the background from left to right are the incinerator and administration buildings, gas storage tank and covered digesters. (Right) Aluminum panels, frames and doors give architectural distinction to the structures.

levels. The dike, which rises 16 ft. above the meadows, incloses an area 1,100 ft. long and 800 ft. wide. A timber trestle 700 ft. long and an approach highway connect the site with the high ground on the mainland.

Because the plant site is within a dike and subject to possible inundation from river infiltration or heavy rainfall, a subsurface drainage system has been installed. Catchbasins distributed over the entire area divert surface water to a central well sump connected with three centrifugal pumps. Two of these pumps (with capacities of 1,440 gpm and 4,900 gpm respectively) are electrically driven, but the third unit (of 6,300-gpm capacity) is gasoline driven. The latter will provide standby service in case of power outages such as have occurred in previous Connecticut Valley floods. These pumps will operate against a head of 37 ft. and discharge through a force main directly into the river.

Some 900 concrete piles and 1,600 wood piles, varying in length from 45 to 50 ft., were driven to support the tanks and structures, as well as to prevent uplift from hydrostatic pressure in periods of high water.

Since the plant is located across the river from the city, an inverted siphon was installed with a length of 1,200 ft. It is constructed of 42-in. cast iron pipe and at the deepest point of the river is about 27 ft. below low water level. The city end of the siphon is connected with a pumping station where two intercepting sewers meet. The flow in one of these sewers, constituting about half the volume going to the plant, has a static head of about 30 ft. and this leads directly into the siphon. Sewage from the other intercepter is pumped into the siphon; for this purpose there are three pumps of 5, 10 and 15-mgd capacity, respectively.

The plant outfall is a 48-in. cast iron pipeline running out 500 ft. in the river. It discharges at a depth of 10 ft.

Grit goes for a ride

Grit removal and disposal facilities were adapted to the special site and hydraulic conditions which prevail at the plant. As will be noted from Fig. 2 the grit chambers, preceded by bar racks, are raised 6 ft. above the ground level. This was done for two reasons: (1) to take advantage of the hydraulic head on the sewage flow line which raised it above the ground surface level and thus eliminated the need for effluent pumping at high river stages; and (2) to minimize the effect of hydrostatic pressure on the structure which otherwise would have required extra piling and additional concrete to resist uplift.

Grit is removed in rectangular chambers equipped with scraper mechanism and a detritor. The latter is a type of classifier which permits the grit to be washed free of organic matter. Because the chambers are several feet above ground level it was found convenient to provide for gravity discharge of washed grit into dump cars which operate on a narrow gage railway track (Fig. 2). Trash rack screenings, which are removed with a hand rake, are also dropped into these cars. When the cars are filled a diesel locomotive pulls the train to the top of the dike over which the cars are emptied into a borrowpit.

The comminutors, which shred the coarser solids in the sewage before it goes to the settling tanks, occupy a section of the administration building. A few years ago before the advent of the comminutor and similar cutting devices, the disagreeable function of handling coarse solids for which these machines were designed, would have been relegated to an inconspicuous part of the plant. It is an interesting commentary on progress

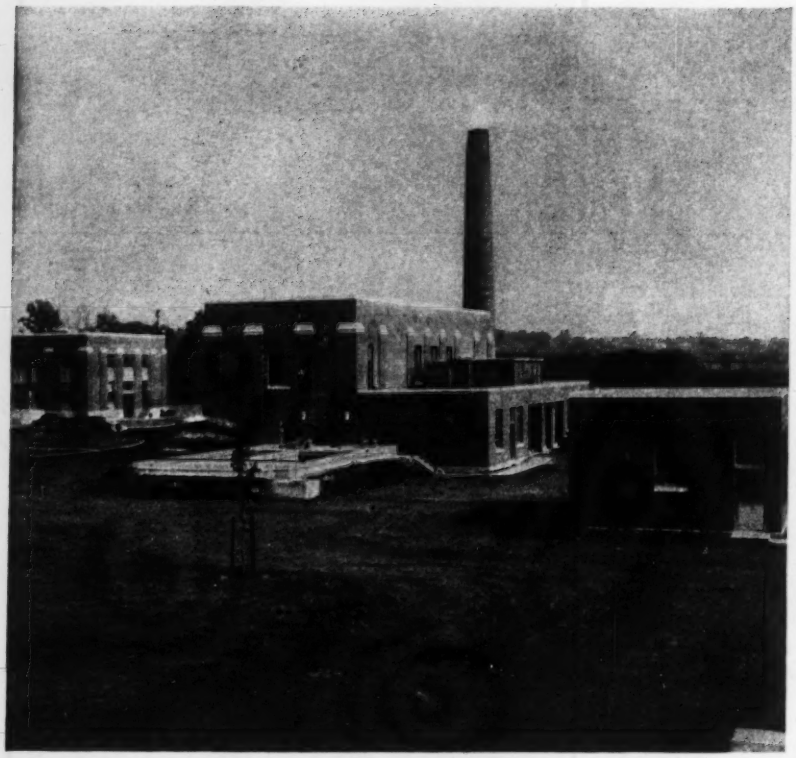


Fig. 3. Sludge processing is carried on in the center building, in front of which are the elutriation tanks. At the left is the administration building and on the right is the gas control house. The latter building is isolated for safety.

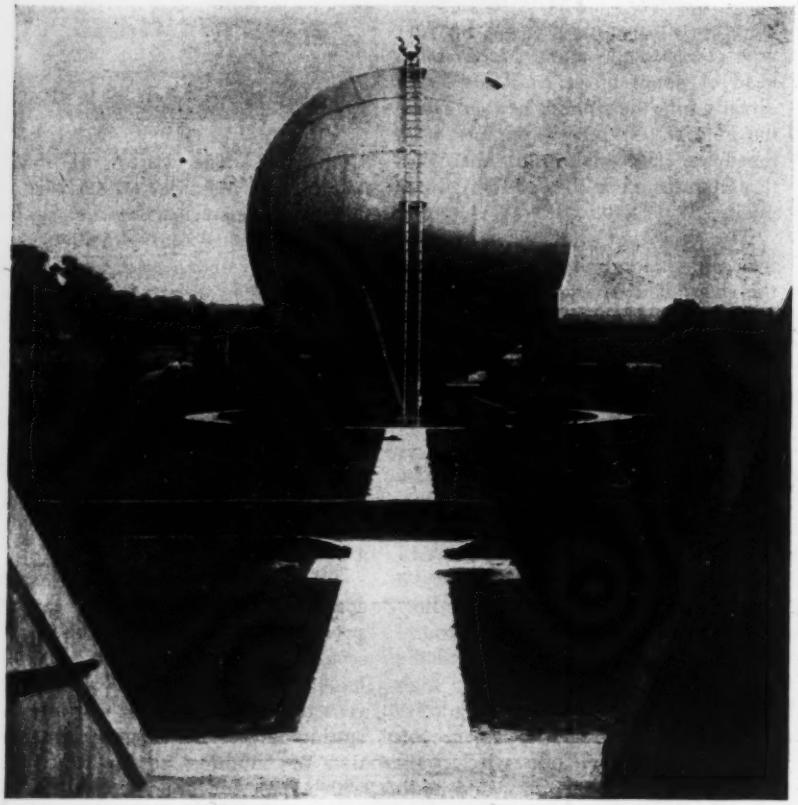


Fig. 4. Dominating the plant as a center of interest is the spherical tank for the storage of sludge gas under pressure.

to note that today this job can be carried on without odor or nuisance within the confines of a building devoted to office, reception and laboratory uses.

The main channel carrying sewage to the three comminutors is inside the administration building and covered with a metal plate. Diffuser plates on the bottom of the channel aerate the sewage to keep it in a fresh condition and minimize deposition of solids.

Sludge treatment and disposal

Design of the sludge treatment and disposal facilities particularly reflects the practice of Gascoigne and Associates, consulting engineers, first demonstrated at Cleveland in 1936. The major characteristic of the layout is the arrangement of sludge digestion tanks around a central control room, and the use of a spherical tank for gas storage.

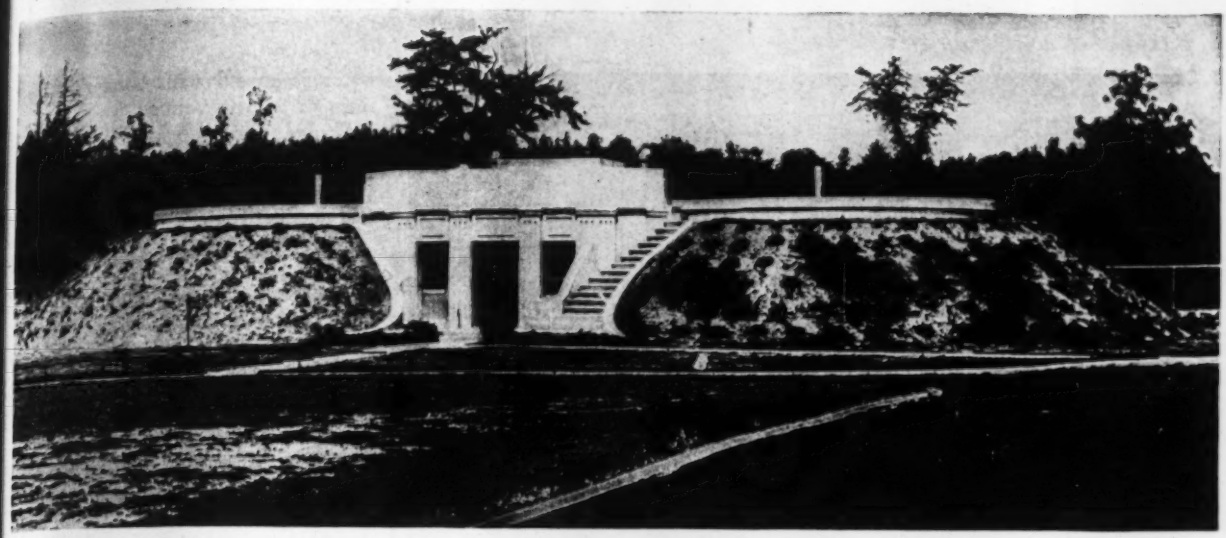
At Springfield a cluster of four digestion tanks, each with a capacity of 47,500 cu.ft., is symmetrically grouped around an interior control chamber. This chamber, formed in part by the circular walls of adjacent tanks contains pumping equipment, sludge sampling connections (see p. 69) and gas measuring apparatus for each digester.

These 55-ft.-diameter tanks are equipped with floating covers, by the aid of which the sludge gas is collected for storage in a 36-ft.-diameter pressure tank. The latter has a capacity of 25,000 cu.ft. of gas at a pressure of 30 lb. per sq. in. Gas will be used for heating sludge, to provide heat for all plant structures, and for auxiliary incinerator fuel.

Elutriation and incineration

Providing for complete destruction of sludge, the Main treatment plant includes vacuum filtration and incinerator facilities, the latter of the flash-drying type. A double-stage sludge elutriation process will also be employed as an adjunct to filtration along with chemical conditioning of sludge.

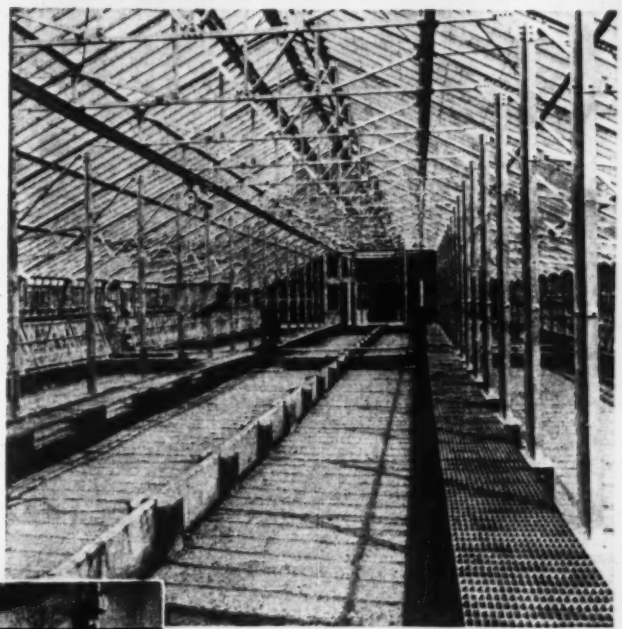
Elutriation of digested sludge will be accomplished prior to chemical conditioning and filtration. The elutriation process is a system for "washing" sludge with water to remove soluble decomposition products. When the latter are washed out the sludge is said to exercise less demand



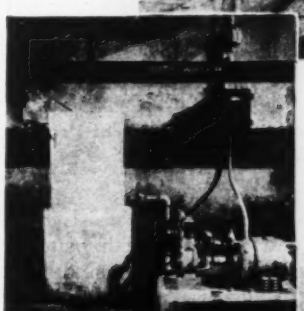
Sludge digesters and control house.

Features of The Indian Orchard Plant

TO TREAT SEWAGE from a section of Springfield not served by the Main Treatment Works this 3-mgd plant was built. It employs primary treatment, sludge digestion and sludge drying on sand beds.

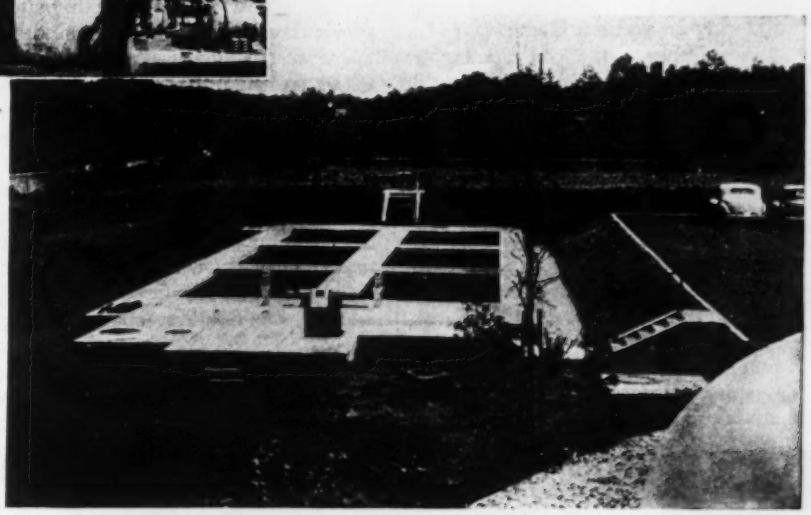


Glass-covered sludge beds.



Air gap plant connection with water main.

Mechanically cleaned clarifiers.



Lighting the gas burner for the first time. Paul Carny, Pacific Flush Tank Co., is doing the ticklish job.

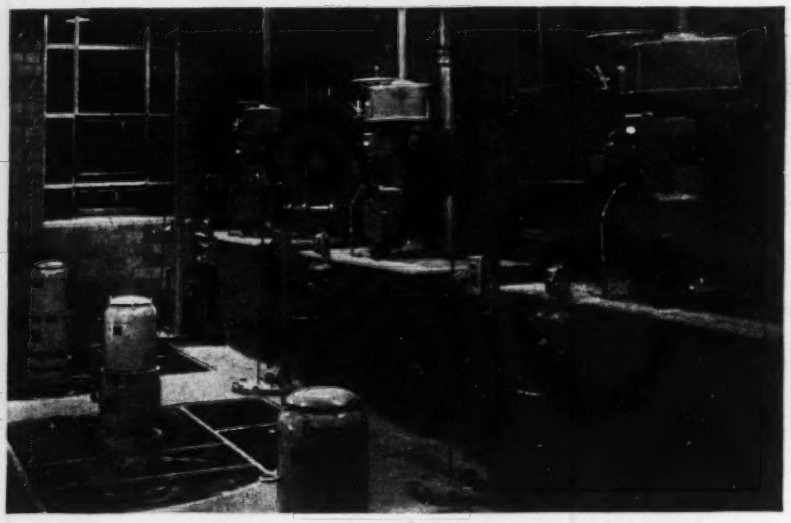


Fig. 5. Control valves and commutators, which are located in a corner of the administration building.

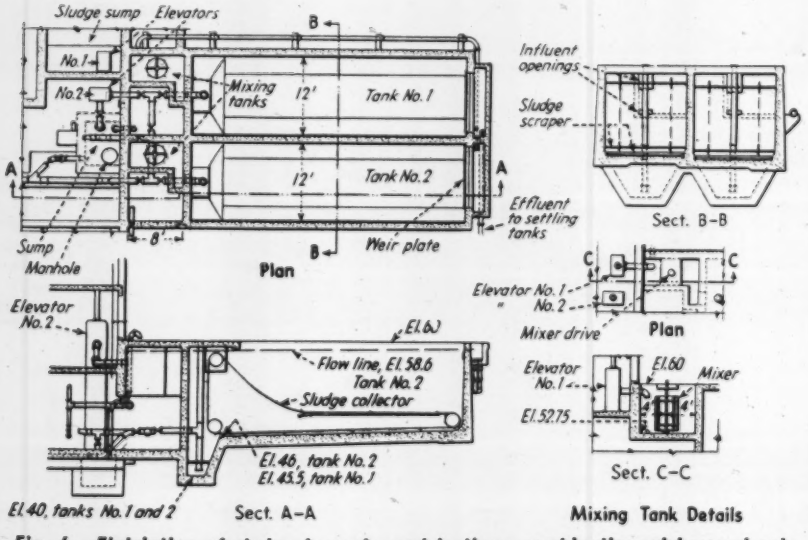


Fig. 6. Elutriation of sludge is performed in these combination mixing and settling tanks. A two-stage system of "washing" is used.

for chemicals (iron and lime) which are required to condition it for dewatering on vacuum filters.

According to the consultants, the operating economies which result from elutriation are: (1) a reduction of more than 50 per cent in the required amount of iron salts; (2) complete elimination of lime, which makes a substantial reduction in the weight of sludge cake to be incinerated; and (3) greater uniformity in conditioning sludge should it be insufficiently digested.

At Springfield a two-stage, continuous counter-current system of washing is used. This requires two mixing and two settling tanks. The first stage of the process consists of mixing digested sludge with water previously used for washing sludge; the washed sludge is then permitted to settle while the elutriate (wash-water containing the decomposition products) overflows for return to the plant influent.

The second stage provides for the mixing of the settled sludge with clean water, followed by another period of settling. It is the elutriate from this second stage tank which is used for the first stage washing process.

Clean water for the elutriation cycle is obtained from wells which have been driven on the site. The water is mixed with sludge in the ratio of 3:1 by volume.

Sludge which has been washed twice in this manner is then ready for chemical conditioning, filtration and incineration.

How the incinerator works

Estimates indicated that the 30-mgd sewage flow will produce about 22,000 lb. dry weight of sludge per day based on 55 per cent removal of solids by sedimentation. Subsequent digestion should effect a 35 per cent reduction of solids, so that a daily load of about 14,300 lbs. (dry weight) of sludge will be produced. It was decided therefore, that an incinerator working on a five-day basis, should have a capacity of about 20,000 lb. daily.

A 10.5-ton unit was selected, employing the flash-drying principles of sludge incineration. This system is of the same type as that which was first installed by the Chicago Sanitary District at the Calumet plant (*ENR*, Jan. 23, 1936, p. 116) and more recently at Buffalo. This process provides four cycles of operation, namely: drying, burning, odor elimination and dust collection.

Sludge cake from the filters is first mixed in a pug mill with a portion of previously dried material. This is done to produce a homogeneous mixture which is then dropped into the dryer. Here it is brought into contact with hot gases from the furnace and drying takes place. Dried sludge, separated from the moisture-laden gases in a cyclone separator, is then conveyed either to the furnace to be burned, or removed from the system for use as fertilizer.

The furnaces are of the flash type, equipped to use sludge gas or oil as auxiliary fuel. They are also designed to receive the moisture-laden gases from the separator and raise their temperature high enough for odor removal. Stack gases from the furnace are passed through a second cyclone separator to remove fly ash.

The Springfield incinerator is designed to handle 32.4 tons per 24 hours of sludge filter cake containing up to 73.5 per cent moisture. Thus it will evaporate 21.9 tons of moisture and incinerate 10.5 tons of dry solids per day.

Planners and builders

Plans and specifications of the Springfield treatment works, as well

DESIGN AND ENGINEERING DATA FOR THE SPRINGFIELD DISPOSAL PLANT

Main Treatment Works

Treatment: Coarse screening; mechanical grit removal; comminution of solids; sedimentation; sludge digestion, elutriation, vacuum filtration, and flashdrying type incineration; gas recovery for heating and incinerator fuel.

Plant Capacity: 30 mgd aver.; 52 mgd max., based on 1955 population of 190,000. Present population 155,000.

Sewage Characteristics: Domestic and industrial waste with suspended solids content of 160 ppm, and a B.O.D. of 175 ppm. Aver. flow per capita daily 158 gal.

Trash Racks: Bar grating with 3-in. openings, manually cleaned.

Grit Chambers: Two units, capacity of each 15 to 62 mgd, with velocity of 0.41 to 1.2 ft. per sec. Min. detention 35 sec. Detritors for grit washing.

Comminutors: Three 36-in. units, capacity of each 21 mgd at max. head loss of 15 in. Solids pass ⅜-in. screen opening.

Clarifiers: Four rectangular tanks, each 50x115 ft.; liquid depth, 14.5 ft.; 2-hr. detention at aver. flow. Equipped with longitudinal and cross sludge collectors. Air-diffusion facilities in approach and inlet channels to prevent sedimentation and to assist in grease separation.

Sludge Digesters: Four tanks with floating covers, each 55 ft. in dia.; water depth to hopper, 21 ft.; hopper depth, 5.3 ft. Total storage, 190,000 cu.ft. Capacity based on 1.0 cu.ft. per capita with a digestion period of 30 days at a temperature of 85 deg. F.

Gas Storage: Collection equipment designed to handle from 0.50 to 2.0 cu.ft. per capita per day. Storage in a 36-ft.-dia. spherical tank holding 50,000 cu.ft. of gas at a pressure of 30 lb. per sq. in.

Sludge Elutriation: Two mixing and settling tanks operated in series. Mixing period 5 min., settling period 3 hr. Each settling tank 40x12 ft. with 12-ft. water depth; equipped with longitudinal sludge collector. Ratio of washwater to sludge, 3 to 1.

Vacuum Filters: Two units each with a filter area of 155 sq.ft., rated at 6 lb. per sq.ft. per hr., producing a cake of 57.5 per cent moisture.

Incinerator: One flash-type furnace equipped with dryer, dust collector, and odor elimination devices. Capacity, 10.5 tons dry weight of digested solids per 24 hr. Sludge gas or oil used as fuel.

Cost: Plant, $1,175,000; river crossing, $180,000.

Indian Orchard Treatment Works

Treatment: Coarse screening with maceration of screenings; grit removal; sedimentation; sludge digestion; air drying of sludge; and gas recovery for heating purposes.

Plant Capacity: 3-mgd aver.; 5-mgd max., based on 1955 population of 10,000, plus an industrial equivalent of 10,000 persons. Present population 7,500.

Sewage Characteristics: Domestic and industrial wastes with per capita daily average of 0.225 lb. suspended solids and B.O.D. of 0.165 lb. Aver. flow per capita daily 150 gal.

Screen Rack: Bar grating with 1½-in. clear openings, manually cleaned. Triturator for grinding and returning screenings to flow.

Grit Chambers: Two parallel V-shaped troughs, each 50 ft. long; capacity from 0.8 to 2.5 mgd at velocities from 0.5 to 1.0 ft. per sec.

Clarifiers: Two rectangular tanks each 16x87 ft., liquid depth 12 ft.; 2-hr. detention at aver. flow. Equipped with longitudinal sludge collectors.

Sludge Digesters: Two tanks with floating covers, each 30 ft. in dia.; water depth to hopper 19 ft.; hopper depth 6 ft. Total capacity 27,000 cu.ft. based on 1.35-cu.ft. per capita capacity.

Gas Collection: Equipment designed to handle from 0.5 to 2.0-cu.ft. capacity daily.

Drying Beds: Two separate glass-covered beds, each 35x150 ft. inside walls, and divided into four beds. Monorail track and dump bucket for removal of dried sludge. Depth of flooding 10 in.

Outfall: 24-in. cast iron submerged, with discharge at mid-channel of Chicopee River opposite plant.

Cost: $210,000.

as consultation on construction, were furnished by Gascoigne and Associates. The project was supervised by Charles A. Emerson of that organization, and J. W. Avery was resident representative.

White and Burke, consulting engineers of Springfield, served as resident construction engineers on the project.

Caye Construction Co. of Brooklyn, N. Y., held the contract on the Main Treatment Works. Tuller Construction Co. of Red Bank, N. J., built the Indian Orchard plant as well as the Connecticut River siphon.

The work was done under the direction of Cornelius W. Phillips, superintendent of streets and engineering, under whose jurisdiction the plants will be operated. John McDonald is in charge of operation, and William Woodward is chemist, their supervision extending to both plants.

Copper May Affect Sludge Digestion

HIGH CONCENTRATIONS OF COPPER, in some cases up to several hundred parts per million, have been found in raw and digested sludge from certain sewage treatment plants, according to C. R. Hoover, of Wesleyan University. Reporting his findings at a recent meeting of the American Chemical Society, Mr. Hoover said that copper is precipitated from solution and the sludge contains 50 to 200 times greater concentration of copper than that in the original sewage.

Laboratory digestion experiments, now being carried on, as well as observations on sewage plant operations, indicate that interference with the rate and completeness of digestion reactions is apparently caused by the accumulation of copper from the traces regularly present in domestic sewage.

The origin of copper in sewage has been traced by systematic analyses of water in streams tributary to reservoirs, in reservoirs before and after copper sulfate treatment, in mains after chlorination, in distributing systems and heating coils of different composition, and in wastes contributed by metallurgical plants. No one of these possible origins appears to be the only source of copper, but each may add small amounts so that waste waters reaching sewage plants may contain from 0.3 to 3 ppm of copper.

Investigation of the mechanism is being carried on by studying the effects of conditions and of a variety of probable components of sewage mixtures, such as proteins, ammonia, colloidal matter, and suspended solids. The effect of pH has already been found to be a most important factor in governing the precipitation of copper.

Biofiltration Comes East

Contents in Brief—A high-rate filtration process of a type employed at a number of West Coast cities has been adopted by Liberty, N. Y., for the treatment of strong sewage. This particular installation offers an example of how a community coupled additional facilities to an existing primary disposal plant to meet higher purification standards

BIOFILTRATION OF SEWAGE, a treatment process for the production of high quality effluent, makes its initial appearance in the East at the Liberty, N. Y., disposal works now nearing completion. More than a dozen installations of this process have been built in the West based on principles developed by Harry N. Jenks, consulting engineer of Palo Alto, Calif. (see *ENR* July 29, 1937, p. 183).

The process consists essentially of rapid filtration through relatively shallow beds of crushed stone. In order to insure high rates of application (far exceeding the rate of plant inflow), part of the filtered sewage is returned to the incoming flow for recirculation. Biofiltration, which can be applied in single or double stages depending on the amount of purification desired, is said to combine in a single form of treatment the advantages of the activated sludge process and those of the standard trickling filter. How it works is shown in Fig. 2.

Liberty had a special problem in sewage disposal. These were the conditions:

An existing sedimentation and chemical treatment plant built in 1931 had become inadequate to cope with present purification requirements.

Because of the popularity of this region as a vacation area, the normal 4,000 population of the village jumps to 10,000 in the summer. This called for flexibility in plant design to treat high and low flows.

Industrial waste from dairy, laundry and slaughtering establishments added to treatment difficulties; the sewage strength is indicated by a biochemical oxygen demand value of 425 parts per million.

The stream receiving the plant effluent has a low flow in the summer period, sometimes less in volume than the treated sewage.

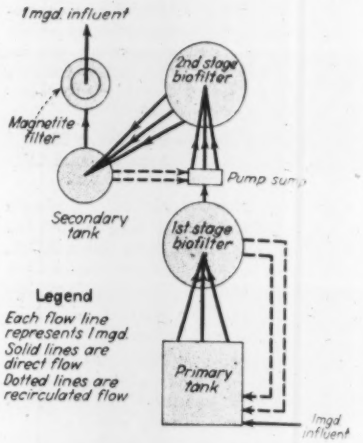


Fig. 2. Schematic flow diagram of the two-stage biofiltration process installed at Liberty, N. Y.

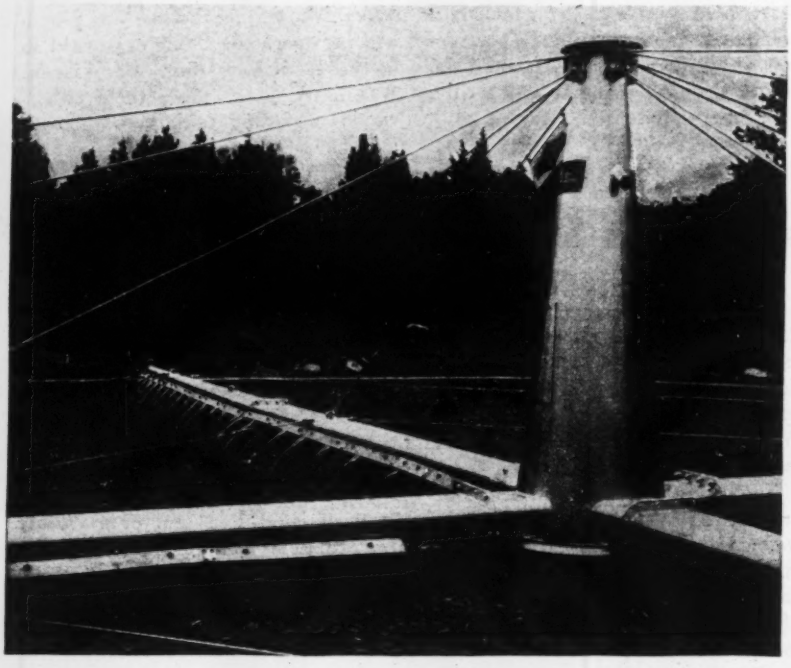


Fig. 1. Revolving and variable flow type distributor used on the biofilter bed.

Analyzing the situation

With these considerations in mind, W. A. Hardenbergh, consulting engineer of New York, who previously had designed the primary treatment plant, stated: "The problem at Liberty was to provide treatment for very strong summer sewage so that it would cause no odor nuisance in the stream below the plant, utilizing methods that could be operated economically and efficiently during the nine months when the biochemical oxygen demand was light."

On the basis of biochemical oxygen demand, the organic loading on the plant varies from a winter average of 1,350 lb. to 3,500 lb. as the summer peak. An effluent was desired with a B.O.D. of 15 to 20 ppm.

An analysis of three processes which could be used indicated the following:

Standard Trickling Filter—Trickling filters followed by sand filters were estimated to cost over $90,000. The major objection to this type of treatment, aside from cost, was the operation of two acres of open sand filters within close proximity to residences.

Activated Sludge—Although the cost of this process could be held to $50,000, there was strong possibility

that operation would be adversely affected by milk waste which entered the plant in the morning, followed by laundry waste in the afternoon.

Biofiltration—Biofilters, combined with a magnetite filter for final "polishing" of the effluents, were estimated to cost $58,000. In addition to reasonable construction cost, it was concluded that this process offered the advantages of providing reliable purification results despite the influence of industrial waste, and also could be operated as a standard trickling filter during the nine-month period of small load.

Equipment and buildings

The final design provided for the installation of two 80-ft.-diameter biofilters, a 60-ft.-diameter secondary settling tank, a 40-ft.-diameter magnetite filter, and two propeller-type recirculation pumps. An additional sludge digestion tank (35 ft. in diameter and 20 ft. deep) and a new office building were also included, so that the total cost of the plant improvement was about $76,000.

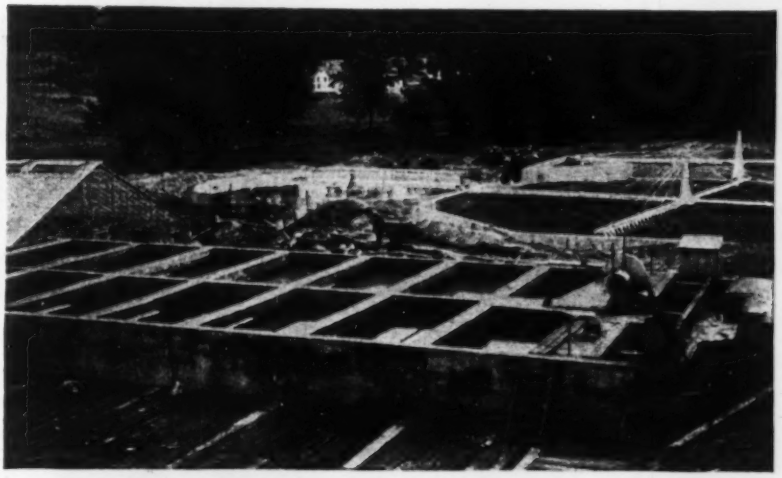
Existing treatment facilities included a grit and screen chamber, coagulation and mixing tank, rectangular primary settling tank, rectangular digestion tank, glass-covered sludge bed, and a vacuum sludge dewatering filter.

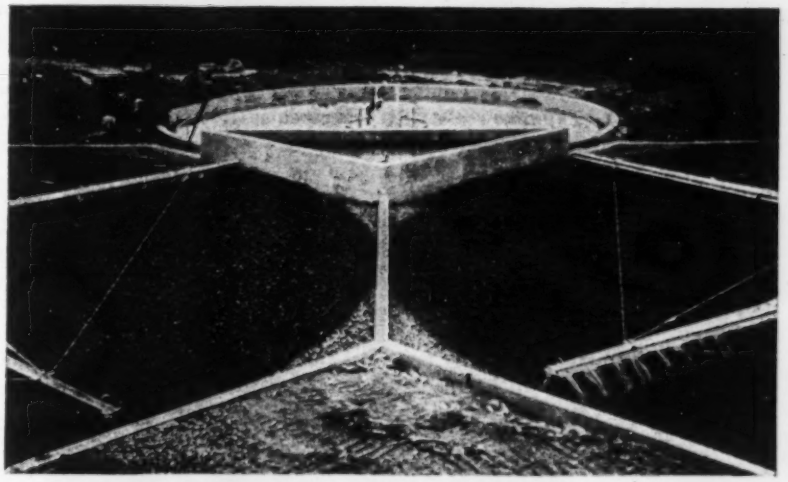
Filter design and operation

The filters are octagonal in shape, and the concrete floor is covered with tile channel and grillage blocks, which support the 3-ft. stone bed. Sewage percolating through the stone passes through the grillage channels, which discharge to a common sump. Around the sides of the filter and on top of the grill blocks a line of inverted 8-in. channel pipe has been laid. Connected with riser pipe in corner of the octagon, this piping arrangement provides additional ventilation of the filter.

The filters contain about 1,250 cu. yd. of stone. With the design flow rate of 1 mgd and a raw sewage strength of 425 ppm B.O.D. the filters have been calculated to carry loading of about 3 lb. per cu.yd. of stone. In the primary filters the stone is sized from 2 to 3 in.; in the secondary filter it is 1 to 2 in. in size, except for a 6-in. bottom layer of 3-in. stone.

A siphon is used to dose the pri-





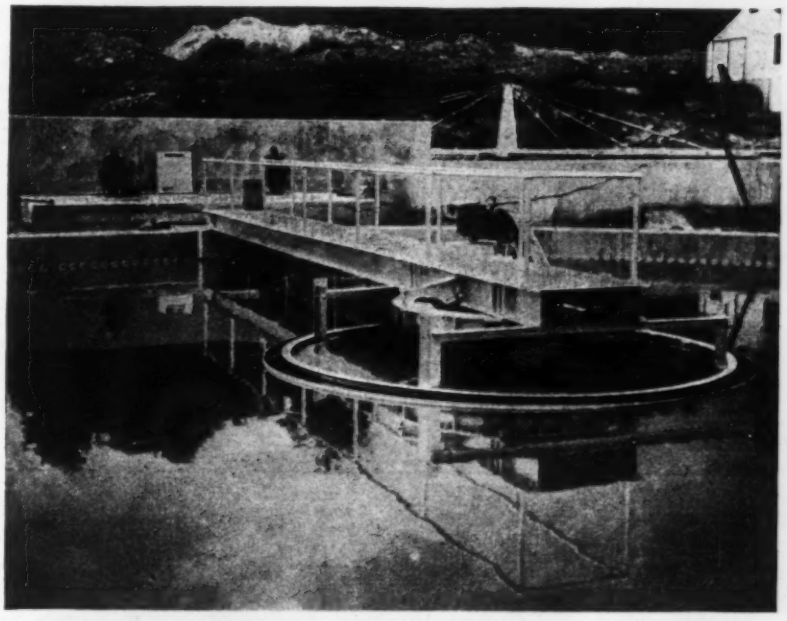


Fig. 3. Plant structures at Liberty include: (Top) primary clarifiers flanked on either side by underground separate digestion tanks; (Center) two octagonal-shaped biofilters, in the rear of which are the siphon and secondary clarifier; and (Bottom) radial flow clarifier with circular sludge scraper.

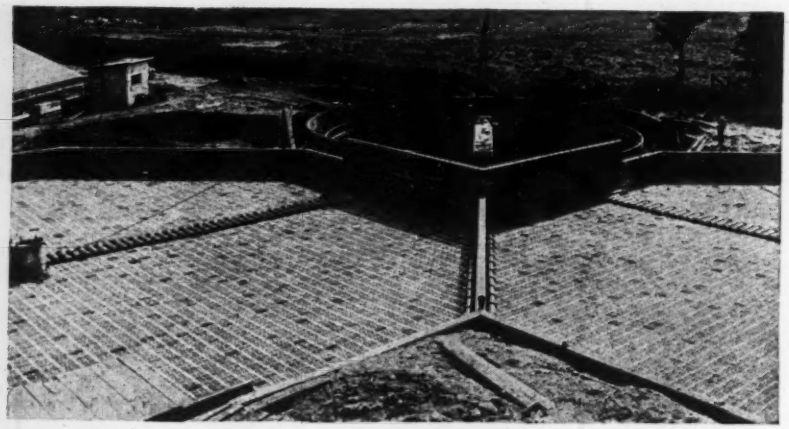


Fig. 4. Underneath the grilled top of the tile filter floor there are parallel channels leading to a central drain. Inverted 8-in. tile channel pipe along the sides of the filter are connected with riser pipes to provide additional ventilation.

mary filter, but the secondary filter is dosed with a 2,100-gpm circulation pump. Piping arrangements are such, however, that the siphon can be used on both filters, with or without recirculation.

Concerning the operation of the filters, it is stated that a recirculation ratio of 2:1 will be used. Thus, when 700 gpm (this is at the rate of 1 mgd) of raw sewage enters the primary settling tank, it will be supplemented with 1,400 gpm of return filter effluent. The total flow of 2,100 gpm then will be applied to the primary filter.

The secondary filter will also be dosed at the rate of 2,100 gpm, consisting of 700 gpm of primary filter effluent supplemented with 1,400 gpm drawn from the secondary settling tank.

All of which means that while the plant receives and discharges 700 gpm, the filters are operated at a rate three times this flow because of the recirculation ratio. At times of low sewage flow, however, the ratio will be higher because the recirculation pumps are fixed in capacity. Thus, despite the amount of incoming flow, the primary recirculation pump constantly will return 1,400 gpm of filter effluent, and the secondary pump will deliver 2,100 gpm to the secondary filter.

A schematic flow diagram (Fig. 2), devised by *Engineering News Record*, clearly shows the operating arrangement used at Liberty.

For added sparkle

After passing through the secondary filter, the effluent is clarified and then given a final "polishing" in a magnetite filter of the downflow type. Details of the filter, which has an area of 470 sq.ft. (filtration rate of 1.5 gal. per sq.ft. per min.) are shown in Fig. 5.

An interesting feature of this tank structure is the utilization of the central circular section for a chlorine contact chamber thus eliminating the need for an additional structure

The Liberty sewage disposal improvements were built under the direction of John Lawrence, superintendent of public works. Harry Eichenauer is in charge of operation. Construction was carried out by E. W. Martin of Liberty, N. Y., from plans prepared by W. A. Hardenbergh, consulting engineer, New York City.

DESIGN AND CAPACITY DATA LIBERTY DISPOSAL PLANT

Treatment: Primary treatment and chemical precipitation facilities built in 1931 include bar screens, a grit chamber, a mixing and coagulation tank, primary clarifiers, a chlorinator, open sludge digesters and glass-covered sand beds. Recent additions include biofilters, secondary clarifier, magnetite filter, covered sludge digester and a vacuum sludge filter.

Plant Capacity: 1 mgd.

Sewage Characteristics: Domestic and industrial wastes. Winter flow 650,000 gpd. Summer flow 800,000 gpd with B.O.D. of 425 ppm and suspended solids of 400-600 ppm.

Screenings and Grit: Combination mechanically cleaned screen and grit remover.

Chemical Mixing: Air mix by means of porous tubes; 20-min. mixing period using aluminum sulphate for coagulation.

Primary Clarifiers: 2 rectangular units, each 70x16x9 deep, equipped with longitudinal sludge scrapers. 3-hr. detention at flow of 1.125 mgd.

Biofilters: 2 beds 80 ft. dia. and 3 ft. deep. B.O.D. loading 3 lb. per cu.yd. of stone. Recirculation ratio 2:1.

Secondary Clarifier: 60-ft-dia. radial flow tank, 8 ft. deep. Circular sludge scraper. 1.5 hr. detention at flow of 3 mgd.

Magnetite Filter: Downflow type in a 41-ft.-dia. tank. Filter rate 1.5 gal. per sq.ft. per min. on bed with an area of 470 sq.ft. Magnetite sand sized so that 98% passes a No. 20 sieve and 95% is retained on a No. 35 sieve.

Digesters: 2 rectangular tanks (70x16x9 ft. deep), unheated, and 1 heated tank, 35-ft. dia. and 20 ft. deep. Total capacity 38,000 cu.ft.

Vacuum Filter: Single drum with 54 sq.ft. area. This unit is an auxiliary to handle sand drying bed overloads.

Sludge Drying Beds: 2 glass-covered beds each 40x58 ft. in area.

Chlorinator: Vacuum feed, capacity about 125 lb. per hr.

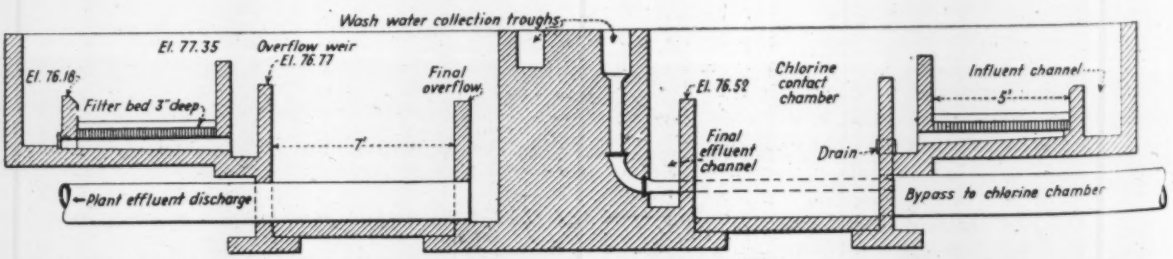


Fig. 5. Sectional view of the circular tank containing the magnetite sand filter and central chlorinating chamber.

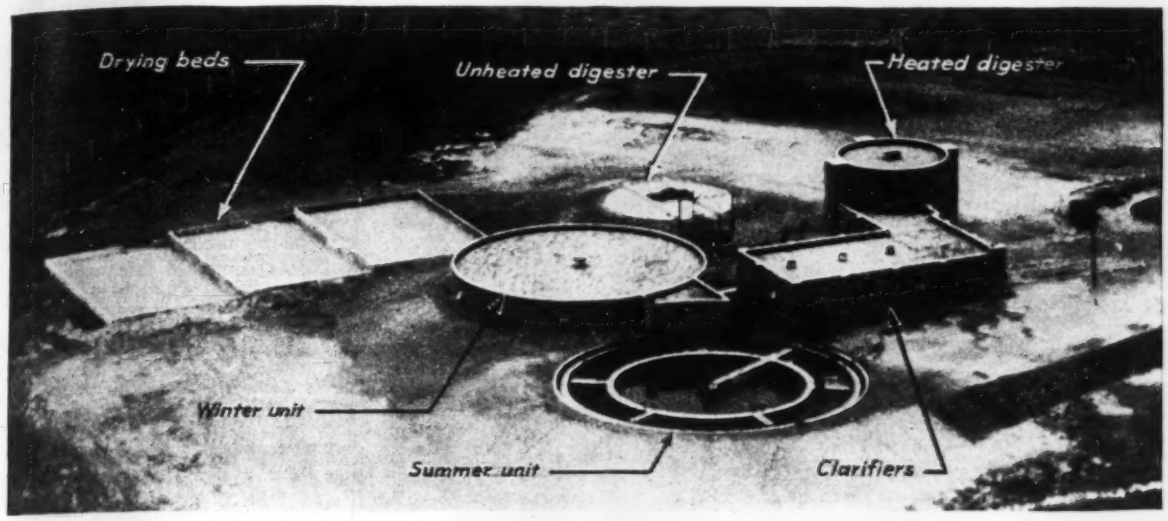


Fig. 1. Dual treatment units provide flexibility where population load varies from 3,000 to 30,000.

Dual Units Solve Resort Sewage Problem

A. Dale Swisher
Sanitary Engineer, Webster City, Iowa

***Contents in Brief**—An activated sludge disposal plant with dual treatment units—one for winter operation and both for use in the summer period—was the solution to handling sewage from an Iowa resort whose population varies from 3,000 to 30,000. Another special feature of the plant is the combination aeration-settling tank unit.*

AN UNUSUAL SEWAGE DISPOSAL PLANT with dual treatment units for handling large and small flows has been built to serve a resort area in Iowa where the population varies from 30,000 in summer to only 3,000 during the major part of the year.

The plant is of the activated sludge type, with the smaller of two units designed for a flow of 750,000 gpd, while the two units together are capable of treating a 1,940,000-gpd peak flow. In place of conventional rectangular activated sludge tanks with separate secondary settling basins, the "Currie Clareater" was used. This is a combination unit, developed by the engineers, consisting of a tank within a tank; the center compartment is used for secondary settling while the annular space between the two tanks serves as the aeration area.

The plant is located near Milford, in the Iowa Great Lakes region. Control of lake pollution in this popular vacation area was recognized as an obligation of the entire state, with the result that the Iowa legislature appropriated funds to pay in part for sewers and a disposal plant. This money was supplemented with federal relief funds, and construction was carried out by WPA. The project included trunk and lateral sewers, and four pumping stations as well as the treatment plant.

Population and flow

A study of the future population of the 100-sq.mi. region indicated an estimated maximum summer population of 36,900 in 1955 and 47,600 in 1990, with an average winter population for the same years of 4,000 and 5,000 respectively. Populations were estimated for these particular years since the collecting system was constructed for the estimated flows of 1990, but the treatment plant, which could be more easily enlarged, was designed for the estimated sewage flow in 1955.

Since it was impractical to provide a treatment system for the flow from a peak population of 30,000 which could also efficiently handle the small flow from the 3,000 winter population, the plant was designed with a large and a small unit.

Raw sewage is conducted through the control house to either one or both of the primary clarifiers. Two primary clarifiers are provided—a 12x45-ft. winter clarifier and an 18x45-ft. summer clarifier, both with a one-hour detention period and a surface area rate of 990 gal. per sq.ft. per day for the estimated maximum flow.

The settled sludge is scraped to collecting hoppers and from there removed by means of a plunger-type sludge pump to the heated digester. Both tanks are skimmed by the use of compressed air under a pressure of 6 lb. per sq.in.

Primary tank effluent flows to aerators where activated sludge is added and the mixture aerated and agitated for a 6-hr. period by blowing compressed air through 400 porous plates located on one side of the tanks. The settling-aeration unit has five aeration segments and a sludge-activa-

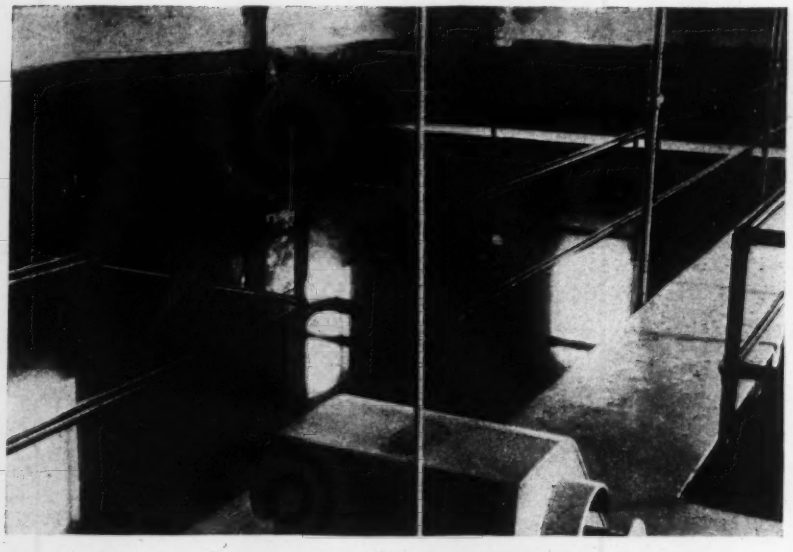


Fig. 2. Primary tanks are housed in the control building to prevent freezing.

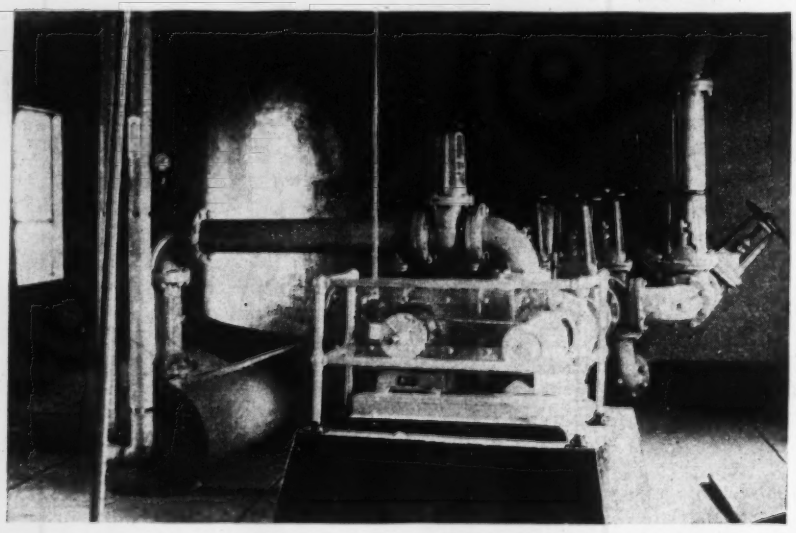


Fig. 3. Circulating pump forces sludge through a cylindrical shell containing pipes heated with hot water. This is a novel method of sludge heating.

tion tank located around the periphery of the final clarifier.

Advantages of dual unit

Chief advantage claimed for this combination unit is a uniform longitudinal flow of sewage through the aeration tanks thus providing a larger and more uniform flow. Other advantages are that the inlet trough around the outer edge serves as a deflector and the valves built into it permit one or more of the segmental tanks to be taken out of service without interfering with the operation of the remaining tanks. The use of a common wall for the two tanks reduces the costs.

After aeration the sewage flows to the secondary clarifiers which are circular radial flow tanks having a detention period of 2½ hr. and a surface area rate of 400 gal. per sq.ft. per day. Two tanks are provided—a summer tank, 48 ft. in diameter, and a winter tank 38 ft. in diameter, both having a side water depth of 8 ft. Both tanks have sludge scraper mechanisms.

Purified effluent from the final clarifier is discharged into the Little Sioux River. Sludge is pumped through a regulating weir box to the activation tanks where it is aerated for 4 hr. to condition it for addition to incoming raw sewage. Excess solids from this aeration process are pumped to the primary clarifier, resettled and pumped to the digester along with primary sludge.

Construction of the aeration tanks about the periphery of the final clarifiers permits of great flexibility in operation. One or more of the six aeration tanks may be used as sludge activation tanks. During the winter, one entire aeration unit will be out of service. In the spring, before the heavy vacation load comes, one or more aeration tanks may be filled with sludge and activated as a reserve to be used when the summer load does come. In this manner the summer unit may be put into service at a moment's notice, thus avoiding a period of low purification.

Separate sludge heater

Sludge from the primary and secondary clarifiers will be treated in a digestion system consisting of a heated tank 30 ft. in diameter for primary digestion and an unheated tank 38 ft. in diameter for settling and storage of digested sludge. The heated digester has a 10-day capacity under maximum load, while the unheated tank provides 4 cu.ft. per capita storage, based on the winter population of 3,000.

Unsatisfactory experience with the usual method of heating the digester with a spiral pipe fastened to the inside wall of the tank led to the use of a sludge heater in the control house. The heater unit consists of a 500-gpm sludge-circulating pump which forces sludge through a cylindrical shell and around a pipe coil containing circulating hot water.

Digestion and sludge storage tanks were not built in duplicate as were other units of the plant since the digestion requirements are quite different from the requirements of the remainder of the plant. At the temperature obtained through the sludge-heater, digestion is complete in a month, after which the resulting sludge can be placed on the sludge-drying beds. These beds provide a drying area of 7,800 sq.ft. During winter months use of the outdoor drying beds is usually impossible and sludge storage is necessary. This is provided for by the idle summer digestion capacity.

The 1 cu.ft. of air per gal. of sewage required in the operation of the aeration tanks is supplied by two 600-cfm blowers which are installed in the control house. These blowers are driven by 50-hp engines operating either on sewage gas or gasoline.

Currie Engineering Co., Webster City, Iowa, prepared the plans and supervised construction.

Problems in Garbage-Sewage Treatment

***Contents in Brief**—Pioneer combination treatment plant for handling ground garbage and sewage sludge, the Lansing, Mich., disposal works recently completed fourteen months of operation. In this period unexpected difficulties have been revealed through clogging of sludge transfer pipes and accelerated digestion. This article tells of the troubles encountered and the remedies suggested.*

AFTER FOURTEEN MONTHS' full operation of the Lansing (Mich.) combined sewage and garbage disposal plant two difficulties stand out prominently in the dual treatment of these wastes. First, bones, eggshells and fruit pits from the garbage settle in the sludge transfer pipes and must be rodded out. Second, the addition of ground garbage directly to the digesters so enriches the sewage sludge that the increased bacterial activity makes it difficult to obtain a clear supernatant liquid.

These obstacles were both unexpected, and it is reported that if the $10,000 asked for by the engineers for an experimental unit had been granted, changes might have been made in the original design. Now, an additional $75,000 is considered necessary to overcome all the difficulties which the full size plant has disclosed. The plant, which cost $900,000, was fully described in *ENR* June 23, 1938, p. 878.

Commenting editorially on this installation in 1938, *Engineering News-Record* said, in part, "Sanitary engineers will watch with interest the operating experiences at Lansing's new sewage treatment plant, where city garbage is to be digested with sludge. Laboratory and semi-plant-scale investigations have demonstrated the feasibility of this method of garbage disposal, but its success in practical application to handling the wastes of a large community has not been established. In a sense, therefore, Lansing is pioneering, though on the strength of research and field results both in this country and abroad."

The information now contributed from Lansing is of great practical value.

Purification performance of the activated sludge plant has met fully all expectations. The B.O.D. removal has averaged 94 to 95 per cent, and suspended solids reduction has averaged slightly under 90 per cent. Far more digester gas has been produced than was anticipated. In fact, the addition of ground garbage (about 0.55 lb. per capita) has increased gas from 100,000 to 230,000 cu.ft. per day.

Facilities for gas utilization are provided in order to take full advantage of the availability of this valuable by-product. The compressor which furnishes air for the activated sludge units is gas operated. The rabble type sludge incinerator is operated as a dryer with the major portion of the fuel gas coming from the digesters. Part of the steam and hot water used in washing the garbage cans is produced by gas. And now the addition of a gas-engine-driven generator set is contemplated.

Residue clogs pipes

Returning to the bone-eggshell-fruit pit trouble, little needs to be added further except to say that the hammermill type of grinder does grind up the bones, break the pits and macerate the shells but the gritty residue is still of heavy specific gravity; and this material settles out quickly in the pipes handling digested sludge.

The pipes are of the minimum 6-in. size used for sludge and the velocity is about 0.6 fps. The latter is too low to prevent deposition and to remove this sediment it often becomes necessary to dismantle pipe joints and resort to the use of rods. Fortunately, no commercial canning

Fig. 1. Washing garbage cans at the Lansing disposal plant after their contents has been emptied into a grinder.

QUANTITIES HANDLED COMPARED WITH THOSE USED AS THE BASIS FOR DESIGN AT LANSING

	Actual	Design Basis
Population	75,000	100,000
Sewage Flow, aver. mgd.	7.49–12 mo.	9
Sewage flow per cap. gpd.	100–12 mo.	90
Aver. garbage daily, lb.	41,580–10 mo.	50,000
Garbage per cap. daily aver.	0.55–10 mo.	0.50

is done in Lansing and the season during which the housewife "puts up" her fruit extends only over two months. While large bones are picked out on the floor as the garbage is dumped alongside the hopper over the grinders, eggshells go in as is and no one has any remedy for their elimination.

As a solution for the grit deposition problem it is proposed to change the present practice of dumping ground garbage directly into the digesters and feed it into the grit chamber instead. The latter is mechanically cleaned. A separate grit chamber for the ground garbage alone is also suggested simply to eliminate bones, eggshells and pits.

The problem in connection with supernatant liquor is revealed by the increase in the solids; prior to adding garbage to the digesters the supernatant contained less than 0.5 per cent solids, but now it carries 2 to 2.4 per cent. The return of this supernatant to the treatment plant has overloaded the aeration process and caused some bulking. Gas production from sewage sludge alone is 1.3 cu.ft. per capita, but with the sewage sludge and ground garbage mixture the gas production goes up to 3.2 cu.ft.

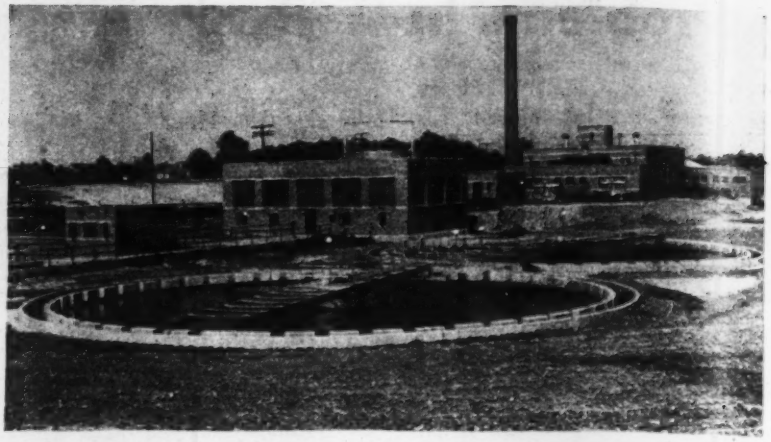


Fig. 2. Final settling tanks and plant structures at the dual disposal plant.

Digestion is active

Shoecraft, Drury & McNamee, consulting engineers for the plant, state in a recent report that the net results of handling the primary sludge, garbage and excess activated sludge in the digesters is to produce a tremendous activity with such a large amount of gas that the contents of the digestion tanks are pretty well stirred up and solids are brought to the top of the tank where they are carried off with supernatant liquor. These solids then go back through the primary tank for resettling, thus putting an added burden on the tanks. The engineers suggest the addition of two or more small tanks for receiving, mixing and seeding of the raw sludge, garbage and activated sludge from which the mixture can then be transferred and passed by stages through the existing tanks. Better control of the supernatant is hoped for, as well as retention of the sludge in the digestion tanks.

Other recommendations were made in the engineers' report. One is for

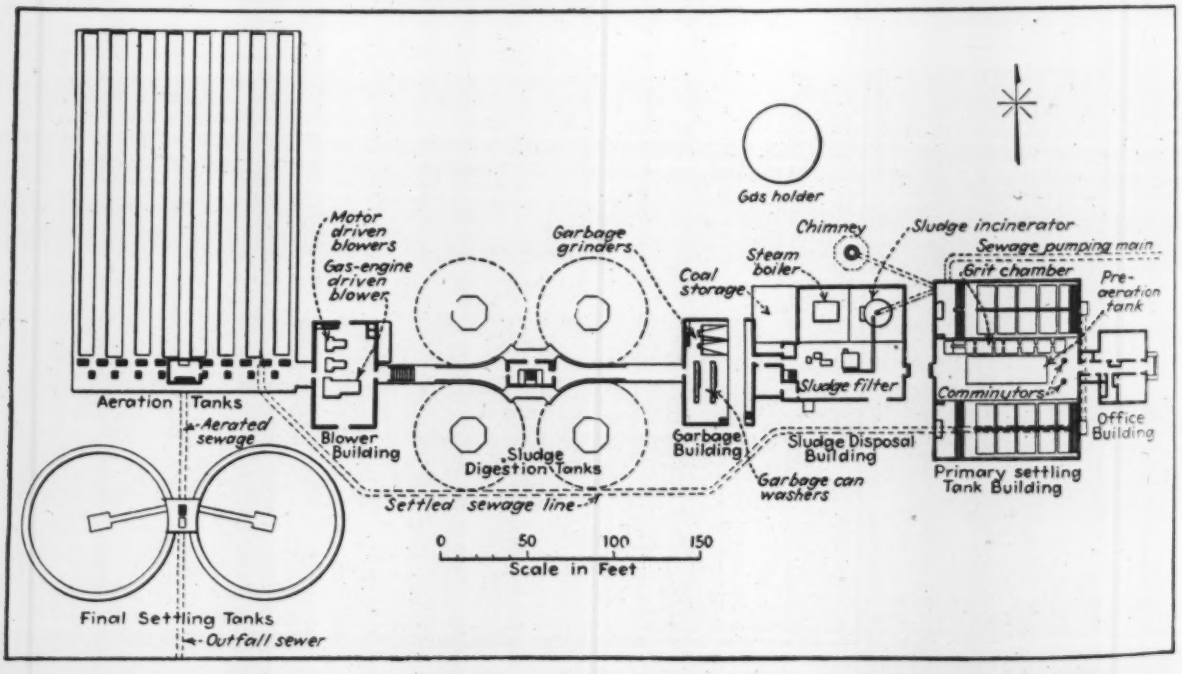


Fig. 3. Layout of the plant which provides activated sludge sewage treatment and garbage digestion with sludge.

another sludge vacuum filter; lack of funds made possible installation of only one of the two planned originally. Tanks are proposed for elutriation of the sludge to remove decomposition products which are said to absorb one-half the lime and ferric chloride now used for conditioning purposes; these chemicals cost $6,000 to $7,000 annually.

Purchased electricity costs $1,500 per month, and it is recommended that a gas-engine-driven generator of 250-kva capacity be installed, which can be operated by excess digester gas.

The estimate for these additional units is as follows:

Vacuum filter	$11,500
8-in. pipeline	600
Additional sludge receiving tanks	30,000
Gas engine generator	18,500
Elutriation tanks	12,300
Truck scales	1,800
	$74,700

With these additions a saving in operating cost of from $12,000 to $15,000 per year is believed feasible, according to the consultants.

Personnel

The Lansing sewage and garbage plant is operated by George F. Wyllie, superintendent of the plant and resident engineer during construction. S. C. Jacka, city engineer, is in general charge of the plant.

Private Contractors May Assist WPA

***Contents in Brief**—Large or special equipment and the efficiency and skill of contractors can be used to assist WPA projects through the medium of the project sponsors contracting for the amount of their participation. Several projects have been successfully completed and general procedure formulated, according to the WPA.*

AN ARRANGEMENT which makes possible increased participation by private contractors in the public works undertakings of WPA sponsors, and at the same time creates additional opportunities for relief employment, is now in operation in a number of states. While the plan is still in a developmental stage and hinges, as does all WPA activity, upon the action of local project sponsors, it is nevertheless a move which points the way toward closer cooperation between contractors and the federal works program, says an announcement from the WPA office in Washington.

In effect, the plan, as outlined and discussed in this announcement, calls for WPA participation in a particular public undertaking through the medium of an approved project the same as before; but it permits the sponsor to participate, or meet his obligation, through the medium of a contract to furnish his share of the supervision, labor, materials and equipment. On projects of this type, WPA participation will consist of furnishing such necessary labor as may be available from the relief rolls, and part of the materials and equipment, just as on other projects.

This procedure, it is stated, will enable sponsors who so desire to make use of the training and skills of private contractors. It will also be possible to operate projects which call for large and expensive equipment which in many cases was not possible before as the sponsor did not have such equipment available and the use of WPA appropriations for such purposes is limited by law. The private contractor should find additional outlets for his equipment and his services as a result. The advantage to the WPA rests in the availability of additional outlets for the use of relief labor on projects where it may be expected that good supervision and ample equipment and materials will be available.

The modified contract procedure has been used on some work since 1936 with the number and scope of operations increasing gradually up to the present. A detailed study by WPA indicated that interest in this method and experience in its use had advanced sufficiently to warrant formulating a nationwide procedure which was done in a release to state WPA administrators April 1, 1940. It is expected that local conditions and attitudes of sponsors will cause considerable variation in desirable contract clauses and this is left to the local groups.

The principles set forth in the procedure do include certain stipulations, however, which will apply to the contract arrangement, particularly to the WPA participation. Under the arrangement, sponsors may follow the usual contractual procedure but it must be made clear to prospective bidders just what participation may be expected from the WPA. Bids submitted are to be for the entire work, less the portion of labor and materials to be supplied without cost to the contractor. The emphasis on such projects is therefore on the contract with incidental WPA participation, and not on the WPA project with incidental participation on the part of the sponsor through the contractor.

Under the contract arrangement the Work Projects Administration is in no sense a party to the contract in which the sponsor may enter, nor will the WPA participate in the preparation of specifications (other than those referring to WPA contribution), the form of the contract, the award of the contract, and the inspection of the work, which are considered the normal and proper functions of the contracting officer.

This of course does not preclude such inspections as the WPA may deem necessary or desirable to determine that the work conforms with the project standards. WPA rules and regulations governing employment, hours of work, monthly earnings, and safety regulations, current at the time of project operation, are of course applicable to all labor furnished through the Works Projects Administration.

The majority of the projects executed to date under the modified contract procedure have been street and highway improvements. The success of a program totaling more than $6,000,000 in two years on New Jersey's highways is attributed largely, it is said, to real cooperation between the WPA, the state highway department and the contractors on 67 different projects.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

EFFLUENT FOR FISH—A question often asked by visitors to a sewage plant is "Can fish live in that water?" Following the example set at several places in the country, Prentice at Lima, Ohio (Ohio Conference on Sewage Treatment, 1939 *Report*) describes the construction of a pool with sloping bottom 26 ft. long, fed by final effluent, and containing goldfish, small-mouthed bass, bluegells, black suckers, hickory shad and carp. The fish increased rapidly in size. During the winter the pond was covered with hinged sections which could be raised on mild and sunny days. The goldfish remained healthy and after spawning increased from 13 to between 500 to 600. The author thinks that, for the amount of money involved, a fish pool maintained by plant effluent, is a very good investment for a sewage plant.

INFANTILE PARALYSIS—The question whether infantile paralysis can be spread by bathing in sewage-polluted waters has been raised by Ellsworth (New England *Journal of Medicine*, 222, 55, 1940), who, in a study of sewage disposal at Fall River, Mass., found that under certain conditions of wind and tide beaches were affected by sewage pollution. In the summer of 1935 Massachusetts was visited by an epidemic of infantile paralysis, the incidence of which, according to the state department of health, reached the third highest figure in the history of the state. Fall River, with 114 cases reported, had the highest incidence of any city or town.

The virus of infantile paralysis can gain entrance into the central nervous system through the olfactory nerve endings. Ellsworth asks: "If sewage carries a sufficient concentration of the virus what better way would there be of producing a case than by frequent flushing of the nasal passages with sewage-polluted water, as would be done in bathing, particularly by youngsters with a natural proclivity for diving and swimming under water?"

Such possibilities are also suggested by the fact that the points of highest incidence in Massachusetts in 1935 seemed to be in communities bordering polluted water used for bathing. "A large number of cases were reported in the Boston Metropolitan District, Salem and Beverly harbors with beaches, some of which are known to be affected by sewage pollution. The cities and towns along the Merrimack River had a high incidence. The highest concentration of pollution occurs near Haverhill, where the disease has prevailed constantly to a greater extent over a number of years than in some other communities of the same size or larger."

Ellsworth states that for every recognized case of the disease there are apparently many unrecognized cases by which infection may be spread. "Since infection through the olfactory nerves is possible, it appears probable that this is a common way of contracting the disease and if a sufficient concentration of the virus is present in polluted water used for bathing it is conceivable that infection results."

MILK WASTE—Milk waste treatment by plain sedimentation, chemicals, sand and trickling filters, and activated sludge has been reported to be effective at various places. Nevertheless, reliable and accurate information regarding the loss of milk and the composition and volume of waste in relation to performance essential for the evaluation of the processes is difficult to obtain. Hatch and Bass (*Proc.* 13th Ohio Conference on Sewage Treatment, 1939) found in comparing three treatment processes (trickling filter, Guggenheim and activated sludge) that the milk solids losses in processing operations of canned evaporated milk, butter and cheese amount to about 2 per cent of the milk solids intake in pounds per day when ordinary care is taken in plant housekeeping. The raw wastes have B.O.D. values varying from 750 to 1,300 p.p.m. In terms of population equivalents the suspended solids in pounds per capita and from 25 to 35 per cent less than domestic sewage. The dissolved organic solids are readily oxidizable by trickling filters or activated sludge processes. Plain sedimentation readily removes 50 per cent of suspended solids and total oxygen demand.

They conclude that milk waste may be treated with excellent results by sedimentation, pH control with lime and activation, with somewhat less satisfactory results by the Guggenheim process. Sedimentation combined with trickling filters is highest in capital cost, but cost less to operate than activated sludge or Guggenheim processes per pound of oxygen demand removed as indicated by the following figures compiled from the report:

	Trickling filter	Guggenheim process	Activated sludge
Flow, gpd	30,800	15,570	29,700
B.O.D. waste, ppm	1,290	750	1,246
Sus. solids waste ppm	754	352	664
B.O.D. removed %	98.2	76.2	98.9
Sus. solids reductions %	93.4	66.0	96.1
Cost in cents per lb. B.O.D. removed	4.05	6.83	4.66

The authors state that the Guggenheim process is capable of producing a better effluent, but careful operation is required. No plant will be entirely automatic in operation.

WASTE SULFITE liquors in concentrations below 80 tons per acre have been found to produce definite increases in yield of sunflowers. The results indicate an increased organic decomposition in the soil, increased solubility of fertilizer ingredients and larger numbers of the soil organisms. Sulfite liquor is a satisfactory source of sulfur for sunflowers grown in sulfur deficient soils. (*Soil Science*. Jan. 1940).

RESTING of a clogged bed or badly pooling trickling filter is said to be wise in order to give the various scavengers a chance to catch up with the growth and debris.

SMALL RED WORMS (*Lumbricullus lineatus*) frequently present in trickling filter beds are very active scavengers, compete for food with fly larvae, help to keep the bed in good condition and reduce the number of flies.

Flame Cleaning Steel for Painting

E. W. Deck

Development Engineer, The Linde Air Products Co., Newark, N. J.

***Contents in Brief**—Flame cleaning has been found to be a highly efficient and economical means for preparing structural steel for painting. This article describes the method in detail and gives typical examples with estimates of the amount of labor and material involved.*

TWENTY YEARS AGO the American Society for Testing Materials uncovered advantages to be gained from the use of flames to prepare steel surfaces for painting. However, it was not until 1936 that a really practicable method was first developed. This method, first used on forgings and castings and known as flame descaling, took advantage of the intense, localized heat of the oxyacetylene flame. During the past few years developments have progressed rapidly to the point where today the process is widely accepted not only for the descaling of billets, castings, and forgings, but, more recently, for the flame cleaning and dehydrating of steel surfaces in preparation for painting.

The ease and economy of applying flame cleaning, plus the resulting high quality of the treated surfaces, are such that the process is now used on all types of structural steelwork, storage tanks, dams, locks, and piling.

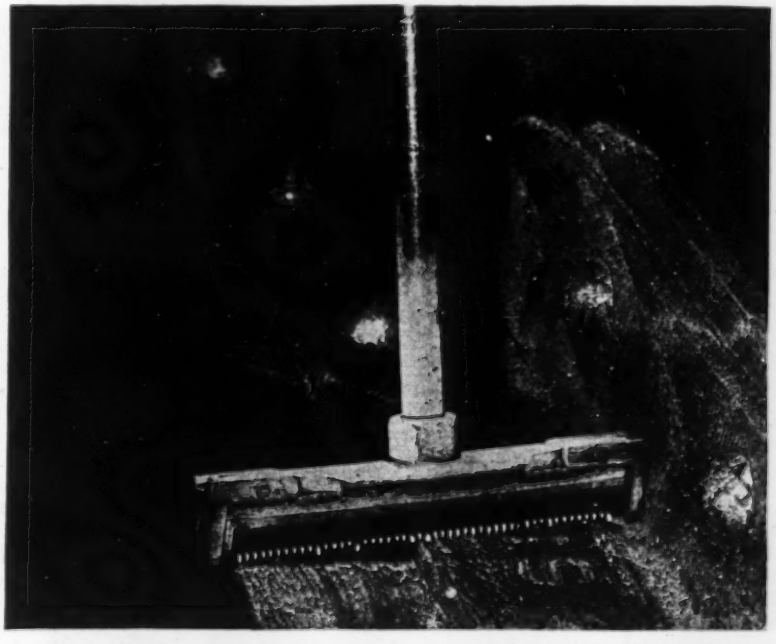
The oxyacetylene flame-cleaning process is designed to improve the surface to be painted, as well as the conditions under which the paint is applied. In comparison with painting surfaces cleaned by other processes, such as wire brushing, pickling, and sandblasting, flame-cleaning offers a number of advantages.

In addition to removing loose scale and rust, the process drives off moisture from the surface, leaving it warm and dry for the application of paint. This heat not only prevents recondensation, but markedly improves the quality of the priming coat. Studies of the action of paint on warm surfaces indicate that the heat, in effect, thins the paint and lowers its surface tension. This imparts a desirable wetting action, causing the vehicle and pigment to penetrate into cracks, crevices, and porous scale. As a result, a mechanical bond is achieved as well as a technically adhesive one. The improved flowing qualities of paint on warm surfaces results in easier brushing and a smoother finish having fewer voids. An accompanying advantage is that the paint sets up more quickly, and from the metal out. This eliminates the tendency of a skin to form and blister, as often happens when the surface is painted in the sun.

Scale that remains not harmful

Some of the tightly adherent oxide scale will withstand the action of the flames. However, it forms an ideal base upon which to apply the priming coat. Iron oxides are often themselves used as pigments in protective coatings, and since mill scale is an iron oxide, it exhibits similar protective properties. Frank N. Speller in "Corrosion—Cause and Prevention," concludes that, provided no moisture is present and the mill scale is tightly adherent, such scale need not be removed. Any scale which resists the rigorous expanding action of the heat of the flames is so tightly adherent that it not only serves to protect the steel from corrosion, but also provides an ideal base for the priming coats.

The action of flames on light scale is quite simple. The intense heat of the oxyacetylene flame instantaneously raises a superficial layer of the scale to a high temperature. The heating is so rapid that the bottom layers of the scale remain at a relatively low temperature and in a brittle state. The result is obvious: The steep thermal gradient across the thin scale sets up tremendous stresses which, because of the brittleness of the cold underlayer, literally pops the scale away from the base metal. The heating action must be rapid, since too



American Bridge Co. photo

Fig. 1. Rivets, corners or irregular surfaces are no obstacle to the flame-cleaning operation. Wear-resistant pads and skids protect the flame ports.

slow heating will cause the scale to become ductile and soft and to fuse to the base metal rather than spall off under stress.

Equipment required

The heart of the oxyacetylene equipment required to produce the rigorous heating action is the heating head. Fig. 1 shows a close-up of such a head in action. The 49 flame ports in this head are spaced $\frac{1}{8}$ in. apart, giving a 6-in. flame coverage. The flame ports are No. 75 drill size, or 20 thousandths of an inch in diameter. Despite the extremely small port diameter, the flames are over $\frac{1}{4}$ in. long, indicating the high velocity of the burning gases.

When operating on flat surfaces the head is spaced the proper distance from the work by the two end skids. These skids are made of Haynes Stellite, an extremely hard, heat-and-wear-resistant alloy. Also made of this special alloy are wear pads which run the entire length on each side of the nose of the head. These pads protect the flame ports in such a way that no matter at what angle, or over what surface the head may be forced, there can be no damage to the head. A typical example is shown in Fig. 1.

Depending on the type of work being performed, the head is attached either directly to the blowpipe, or to the blowpipe by means of an extension arm. The blowpipe, in turn, is connected by lengths of hose to suitable supplies of oxygen and acetylene. A typical set-up consisting of an oxygen cylinder and a 3-cylinder acetylene manifold is shown in Fig. 2.

The equipment is highly adaptable and easily handled. Despite its seeming simplicity, however, years of development work have been required to bring the apparatus to its present state of perfection.

In discussing flame-cleaning procedures it might be well to follow as an outline the sample flame-cleaning specifications released recently by the American Institute of Steel Construction. These specifications, which follow, were prepared primarily for the structural steel industry, but they are applicable generally. Supplementary specifications cover cleaning and painting boxed members.

Summarizing, the cleaning and painting procedure requires four major operations. These are: (1) oil and grease removal; (2) flame cleaning; (3) wire brushing; and (4) painting. Each of these will be discussed in order.

Removal of oil and grease

The purpose of cleaning first with solvents is to remove any oil or grease which may have accumulated on the parts during fabrication. While the oxyacetylene flame could be used to burn off these flammable materials, the procedure is slow compared to normal cleaning speeds. A helper with a bucket of mineral-spirit solvent and a hand mop usually performs this operation. By working well in advance of the flame-cleaning operator, he is able to scrub the surface and mop up the residue in time so that the surface is free from flammable material before the flames reach it, even when he uses less volatile cleaners. The mopping-up operation is important, because the residue which settles in the low spots tends to be tar-like and gummy, and slows up flame-cleaning operation.

Oxyacetylene flames are specified for the flame-cleaning operation because, on the basis of tests (*Civil Engineering*, July, 1940, p. 413), other gases have been found unsuited. This is because the high flame intensity desired is obtained only by the combustion of oxygen and acetylene. In addition, the low-temperature, low-velocity flames obtained by other fuel gases produce from 70 per cent to 200 per cent more water vapor than does acetylene. This is an important consideration, since dehydration is a major objective of the flame-cleaning process.

The specification for an oxygen-acetylene ratio of at least one is included to prevent the use of carbonizing, or smoky flames. This gas ratio represents a neutral flame. Higher ratios are permissible and even recommended in view of increases in flame temperature and velocity, but because the neutral flame is set readily by means of visual examination, it is recommended. There need be no fear of oxidizing ratios having any deleterious effect upon the metal surfaces since under no conditions are metal temperatures sufficiently high for the surface to oxidize.

In specifying a ratio of flame length to port diameter, the AISC has, in effect, set up an index of flame velocity. The longer the flame burning from a port, the greater its average port velocity. While the minimum value is now set at 8, flame-cleaning heads, such as the one illustrated in Fig. 1, produce flames which have a length-to-diameter ratio of at least 50 per cent higher than this figure.

It is difficult to set down specific

SPECIFICATIONS FOR FLAME CLEANING STRUCTURAL STEEL

ACCORDING to the specifications of the American Institute of Steel Construction, flame cleaning shall signify the following sequence of operations:

1. Oil, grease and similar adherent matter shall be removed by washing with a suitable solvent. Excess solvent shall be wiped from the work before proceeding with subsequent operations.

2. The surfaces to be painted shall be cleaned and dehydrated (freed from occluded moisture) by the passage of oxyacetylene flames which have an oxygen to acetylene ratio of at least one. The inner cones of these flames shall have a ratio of length to port diameter of at least 8, and shall be not more than 0.15 inches, center to center. The oxyacetylene flames shall be traversed over the surfaces of the steel in such manner and at such speed that the surfaces are dehydrated; the dirt, rust, loose scale, scale in the form of blisters or scabs, and similar foreign matter are freed by the rapid, intense heating by the flames. The flames shall not be traversed so slowly that loose scale or other foreign matter is fused to the surface of the steel. The number, arrangement and manipulation of the flames shall be such that all parts of the surface to be painted are adequately cleaned and dehydrated.

3. Promptly after the application of the flames, the surfaces of the steel shall be wire-brushed, hand-scraped wherever necessary, and then swept and dusted to remove all free material and foreign particles. Compressed air shall not be used for this operation.

4. Paint shall be applied promptly after the steel has been cleaned and while the temperature of the steel is still above that of the surrounding atmosphere, so that there will be no recondensation of moisture on the cleaned surfaces.

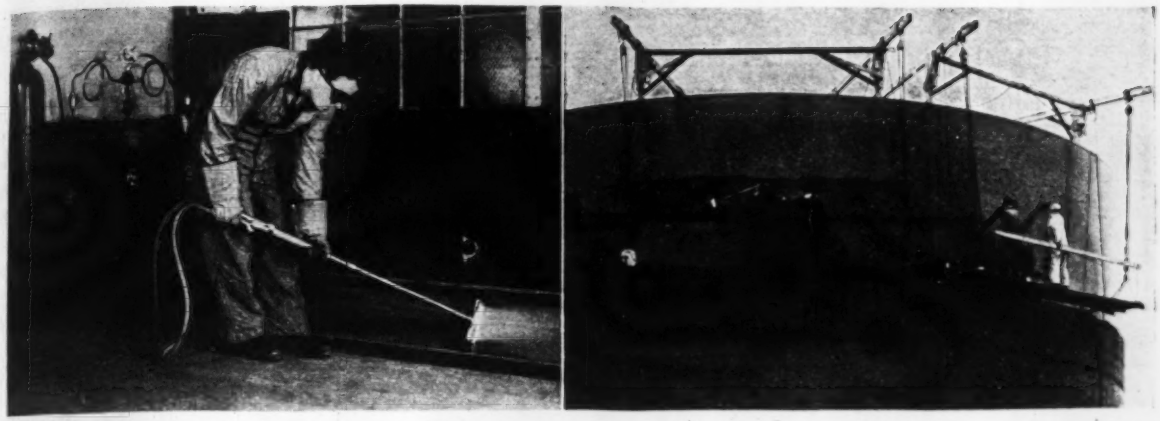


Fig. 2. Equipment normally used in flame cleaning. It includes the head and blowpipe (with or without extension arms) a 3-cylinder acetylene manifold and an oxygen cylinder. The operator wears clear glass goggles. (At right) Typical set-up for flame cleaning and painting tanks. Comparative tests show that flame cleaning requires less than half the time of sand-blasting and costs half as much.

recommendations for performing the actual cleaning operation because these will vary according to the type of work being handled. Early, tentative specifications called for changing heads whenever the surface conditions changed, such as when rivet heads were encountered. As more suitable equipment with high flashback resistance and suitable protecting surfaces was developed, it became evident that such practices were superfluous. It was shown that a 6-in. head could be manipulated easily into corners, around rivet heads, and along narrow flanges without waste of gases, and yet clean as well as a smaller head. The blowpipe is usually held so that the flames impinge at an angle of 60 deg. plus or minus 15 deg. Operating with the flames normal to the plate is somewhat more efficient but is not practical because of difficulties in handling and in watching the action of the flames. The blowpipe operates equally well on vertical or horizontal surfaces and can be pushed or pulled as shown in Fig. 2.

The speed of blowpipe travel is easily governed and can be learned by the operator after a little practice. As already mentioned, too slow speeds will tend to fuse the scale, rather than flake it off. On the other hand, there will be little tendency on the part of the operator to work too fast, or to form gaps or "holidays," because such indications of too much speed will be readily visible. Note, for instance, the marked difference in appearance between the original and the treated surface shown in Fig. 1. In working around rivets, the tendency is to linger and overdo the job, rather than skimp. In addition, because close inspection is usually furnished and because the operation is followed closely by brushing and painting crews, there is little opportunity for slipshod work.

Wire brushing and dust removal

The wire-brushing which follows the application of the flames is the equivalent roughly of the usual hand-cleaning operation. It is much easier after flame cleaning, however, because only a light pressure is required to reach the clean surface. Old but well-cleaned paint brushes are best suited to brushing off the dirt and freed scale as required by the specifications. Compressed air should not be used to blow away any loose scale and clean the surface because of the moisture and oil usually present in such air.

Painting

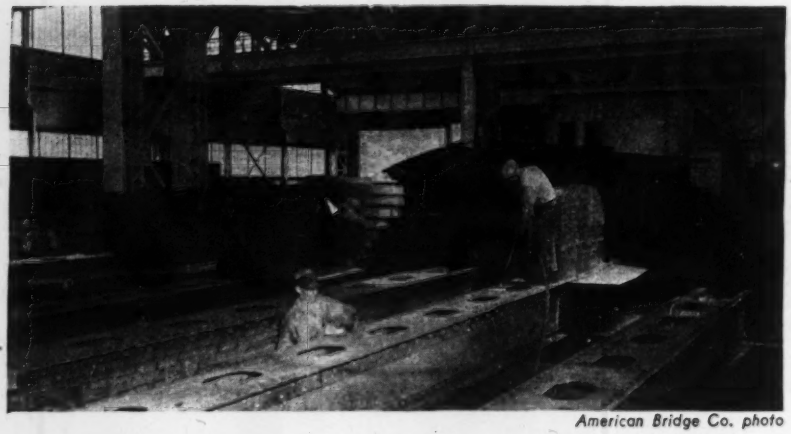
The problem of painting flame-cleaned surfaces is outside the scope of this article except in so far as the specifications require that the surface be painted before it reaches the temperature of the surrounding air. The time interval between cleaning and painting will vary, but, in general, it should not exceed 2 hr. The advantages of applying paint on warm surfaces have already been covered. A practical point in this regard is that when shutdowns occur, as at the end of the day, the painters should finish up all material which has been cleaned. If this is not done, rust will form rapidly on the cleaned surfaces, requiring a second application of the flames before painting.

The actual temperature existing in the metal is not readily predictable. If the surface bears a relatively loose scale all over, the flames can proceed rapidly and the major amount of heat will go off in the flying scale. Such a surface would not show a considerable temperature rise. A much greater temperature rise can be expected when the scale has been partially removed and the flames play directly on the metal. Thin, light members can also be expected to show a greater rise in temperature because the same amount of heat is distributed throughout a much smaller mass of backing-up metal. Generally speaking, the temperature of the metal will be between 120 and 150 deg. F. after normal operations. Paints can readily stand temperatures up to 250 deg. F.

Operating speeds and costs

Completely satisfactory results on relatively new materials have been obtained at flame-cleaning speeds as high as 50 ft. per min. However, such speeds cannot be realized over long periods or on many types of products. Speeds of from 20 to 40 ft. per min. are the best that should be anticipated on structural steels. A value of 1,000 sq. ft. per blowpipe-hour (using a 6-in.-wide head) is a representative maximum value from which to start to make deductions for contingencies.

At this speed, about 13 cu. ft. of oxygen and the same volume of acetylene are required per 100 sq. ft. of surface. For standard sections, the consumptions will run between 30 and 50 cu. ft. per ton when cleaning



American Bridge Co. photo

Fig. 3. Flame cleaning, wire brushing and painting structural steel in the shop.

the entire surface. Light channels and angles may run over 100 cu. ft. per ton. It should be remembered that these figures are based on blowpipe burning time when working on flat, smooth surfaces. The speed will probably be reduced 50 per cent on riveted areas, with a corresponding increase in gas consumption.

It should be mentioned here that skilled labor is not required to perform the flame-cleaning operation, and the technique of actual cleaning can be learned in a very short time. In addition to handling the blowpipe, most operators are also responsible for attending to the gas supply.

Flame-cleaning applications

Perhaps the widest use for the flame-cleaning process today is on structural steelwork such as is used in bridge construction. Fig 3 shows a typical shop layout for this type of work. The sub-assemblies are top chords for a bridge truss. The operator is flame cleaning the cover plate of one of the members, while in the foreground can be seen the wire-brusher. In the rear is the painter working on a previously cleaned section. The speed on this job is average —approximately 30 ft. per min.— using a 6-in. head with 20-in. blowpipe extension.

Large storage tanks, such as the one shown in Fig. 2, are ideal applications for flame cleaning. In order to obtain comparative figures, some of the tanks owned by the same company were flame-cleaned while others were cleaned by sandblasting. Based on the results of the tests, the owner of these tanks has standardized on flame cleaning for this and other jobs.

As shown in the illustration, the work proceeded around the tanks in courses about 7 ft. high, with the painters always following closely behind the cleaners. Because of the difficulty in setting up scaffolds and moving them, the blowpipe time was about half the total time. Despite delays, however, the time consumed for flame cleaning and painting was considerably less than for sandblasting and painting. In the latter process, the sandblasting had to be performed independently of the painting so that the flying dust envelope would not settle on the fresh paint. To do this, a single course was completely sandblasted. Work was then stopped while the clean surface was painted.

Comparative data on tank work

Operating data for flame cleaning these tanks can be summarized as follows:

The flame-cleaning rate per blowpipe hour was 60 per cent of that estimated for flat surfaces. The blowpipe was in use 40 per cent of the time required for the job. Sandblasting alone required 50 per cent longer (actual operating time) than flame cleaning and painting. Since the painting could not proceed during sandblasting, the operation was performed in alternate steps and required 140 per cent longer overall time.

The painters' rate was 10 per cent faster on the warm, flame-cleaned surface than on the sandblasted finish, and, at the same time, only 90 per cent as much paint was required since it spread more readily over the smooth, warm surface. The net time required for preparing the surface and applying the priming coat was 80 per cent longer in the case of sandblasting. At the gas and labor rates in this plant, sandblasting cost 110 per cent more than flame cleaning and represented 55 per cent of the total cost of preparation and painting.

Marine work

The U.S. Navy specifications, 34-YA, issued by the Bureau of Yards and Docks, require the use of flame cleaning prior to the application of protective coatings. Much of this work has already been done and, on the whole, the performances indicate that speeds will be about the same as on structural materials.

Flame cleaning bulkhead piling to Navy specifications falls into practically the same class as structural steel. Scale formations are the same and the handling of the equipment is identical. In some cases, where the steelwork extends above the high-tide level, the surfaces are cleaned and coated after placing, in which case cleaning speeds are governed primarily by accessibility.

The flame cleaning of dams and locks falls into much the same category as naval equipment, except that maintenance is usually an annual problem. In such cases, the surfaces are usually wet from spray and high humidity. As a result, the paint never adheres for any length of time nor does it perform a corrosion-resisting function. The flame-cleaning process burns off the traces of old paint, leaving clean warm metal which is not only dry but will remain so, even in the presence of spray, until the priming coat has been applied. The advantages of this practice are self-evident.

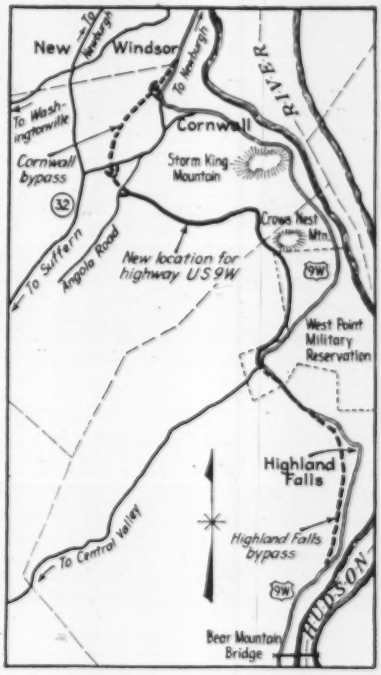
There exists a very large potential market on existing structures for flame cleaning in the removal of old paint and preparing the surface for repainting. Current flame-cleaning equipment is not generally recommended for the removal of paint, however, unless the surface below the paint has been corroded to the point where the paint may be removed with the scale without appreciable burning of the paint. Air-acetylene paint burning equipment or mechanical methods (*Civil Engineering*, July 1940, p. 416) should otherwise be employed for paint removal prior to flame cleaning. Additional research investigations, furthermore, are being conducted which may result in the development of special equipment for accomplishing the paint removal and surface preparation simultaneously.

New York Builds Mountain Highway To Bypass Old Storm King Road

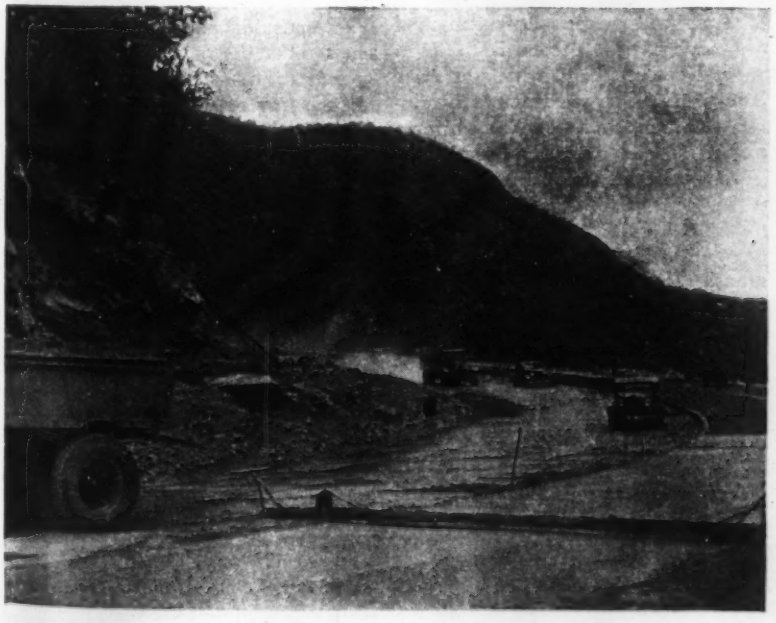
***Contents in Brief**—A new highway through the mountains back of West Point is being built by the State of New York to eliminate bad sections of main road on the west side of the Hudson River. One section, now completed, bypasses the old Storm King Highway. Numerous blends of cement are being used in the pavement that is laid on the steep grades of the latter section.*

NEW YORK STATE has just completed 5.25 miles of new dual highway through the mountains back of the West Point Military Reservation as part of a program to improve the alignment and eliminate narrow, winding sections of the main highway on the west side of the Hudson River between Bear Mountain Park and Cornwall. The new section of road back of West Point is notable because in order to obtain satisfactory alignment it was necessary to carry the highway to a point 1,200 ft. above the river, introducing grades of 7 per cent and over. Also notable is the fact that for steep grade sections a wide variety of blends of a standard portland and natural cement was used as part of the state's extensive study of blended cements in highway paving.

The new road will take through highway traffic out of the developed section of the West Point Reservation; it also will divert the traffic from the highway built around the face of Storm King Mountain back in 1922, a road that frequently is made dangerous by rock falls and is too crooked and narrow for safe or convenient operation as a main highway. To the south of the new highway behind West Point the old road is being widened and relocated to avoid the narrow streets of the village of Highland Falls, the relocation being carried south to connect with a section of the highway north of Bear Mountain Bridge that was improved a few years ago. To the north, beyond the point where the new highway connects with the Angola road into Cornwall, a second section of new road is being built to bypass the village of Cornwall. In all, there will be 12.2 miles of new highway which will cut the total distance on this section of U.S. 9W by about half a mile. While this saving in distance is small it is believed that the better alignment, greater road width, divided lane traffic and avoidance of congestion will save ten to fifteen minutes in driving time, and the trip will be made with none of the nervous strain involved in traveling over the old road around Storm King.



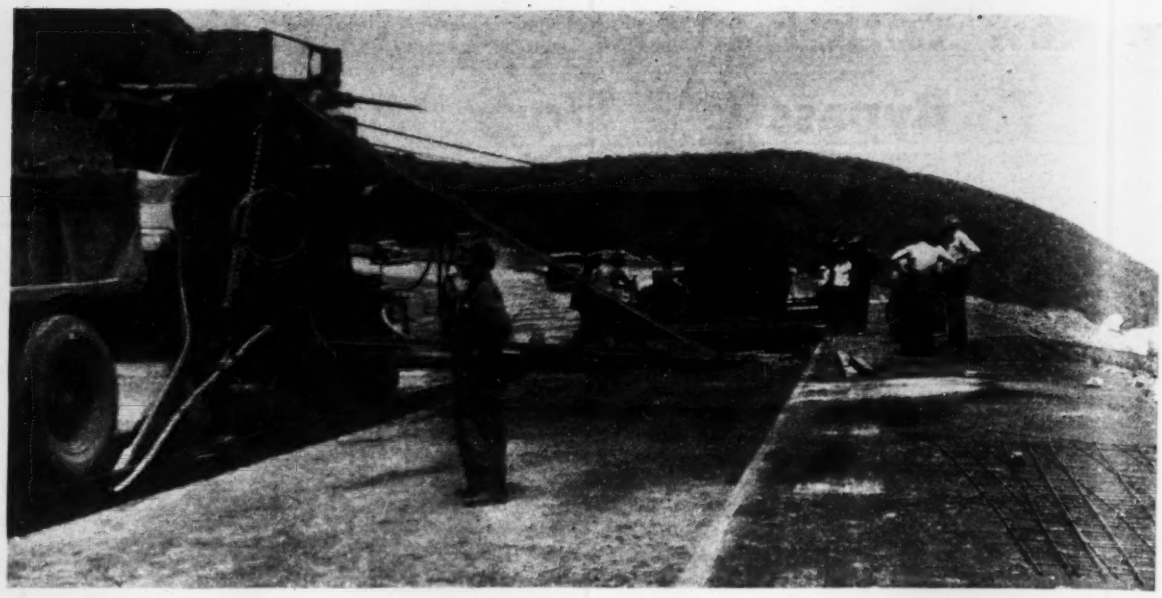
The new West Point-Cornwall highway will make it unnecessary for through traffic to use the narrow, winding road around Storm King Mountain. A relocation to the south and a new connecting road to the north will take the highway out of the village streets of Highland Falls and Cornwall.



The cut at the sharpest curve has been widened to give ample sight distance.

Relocation back of West Point

The new highway back of West Point leaves the present road at its intersection with the secondary road from Central Valley to West Point in a narrow valley at the back of the reservation. The level of the main north-south highway at this point is being raised to permit the



Placing concrete in one lane of the new four-lane dual highway 1,000 ft. above the Hudson River near West Point.

Central Valley road to be carried under it. From this intersection the new road climbs steadily for about 1½ miles on a nearly uniform 7 per cent grade to the summit at El. 1,236. This section begins with a short piece of 6 per cent grade and has one short section of 8 per cent grade. From the summit, the descent to the north is less abrupt, but nevertheless it was necessary to use long sections of 7 per cent grade and one section of 7.6 per cent.

Sharp curves have been avoided. Only a few curves have a radius of less than 881 ft. and the sharpest curve (radius 410 ft.) around a mountain spur has had the inside cut widened to improve the sight distance. The pavement on this curve has been banked at the rate of 1⅛ in. per foot of width. On other curves of radius less than 700 ft. the banking is ⅞ in. per foot, and lesser amounts are used on the flatter curves.

Much of the road is on a side-hill location requiring deep side cuts (maximum 80 ft.) and retaining walls up to 50 ft. high. These walls have a gravity section and are built of heavy stone masonry, the top being carried above the roadway level to provide a substantial parapet. About 36,700 cu.yd. of rock went into the retaining walls.

Earth and rock excavation amounted to nearly 700,000 cu.yd., of which 450,000 cu.yd. went into the fills. The remainder was wasted on the precipitous slopes.

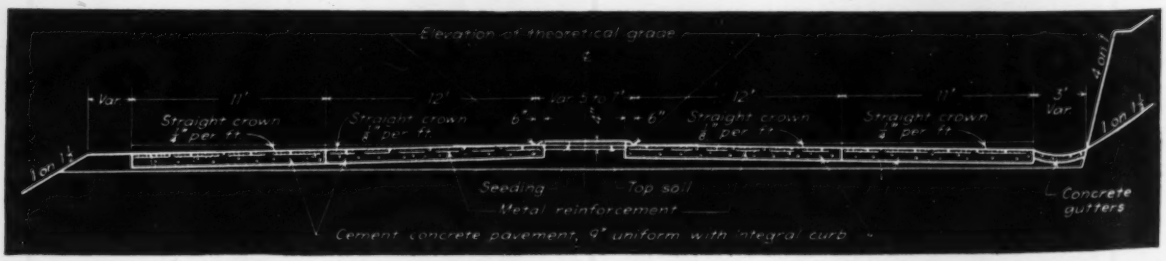
Roadway design

The new road is a four-lane divided highway with a sodded central mall of varying width from 5 to 7 ft. Inner lanes are 12 ft. wide and outer lanes 11 ft. The pavement is a reinforced concrete slab of 9-in. uniform thickness laid on a bed of rolled gravel of a minimum thickness of 6 in. Concrete gutters having a minimum width of 3 ft. are used on side cuts. They drain to drop inlets. Drop inlets also are used along the curbs of the mall on the inside of curves where the banking throws the roadway drainage toward the mall.

The surface of the new concrete throughout the whole job is heavily broomed to give a rough texture to aid traction on the steep grades. On all grades of 7 per cent and over, added traction is provided by grooves about ½ in. deep at 6-in. intervals made by pressing into the green concrete two parallel reinforcing bars bound together and made rigid by metal trussing.

Blended cements used

Because of the steep grades on this new road, the pavements will be exposed to unusually harsh treatment in the way of sanding and the application of calcium chloride to check freezing. Consequently, the state highway department is using this new pavement for field tests of various blends of standard portland cement and natural cement that have been under study for some time in an effort to improve the wearing quality of the surface of concrete



Typical cross-section of the new road. Minor variations are made in the width of the mall to suit local conditions.

highways. Five brands of portland cement are used, two from the Hudson valley mills, North American and Lone Star, and three from the Lehigh valley mills, Lehigh, Dragon and Pioneer. Natural cement is Century from Rosendale, N. Y. One carload of high-silica cement also was used.

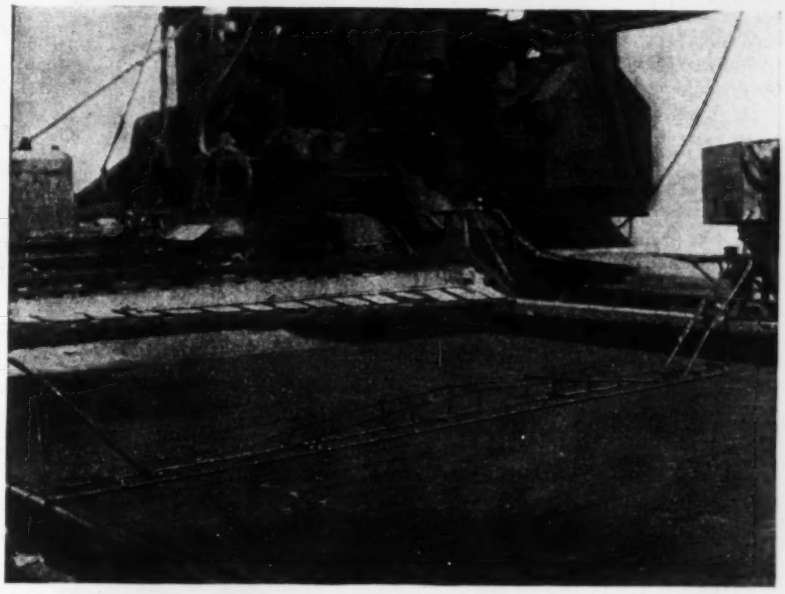
For the test purposes, the pavement was divided into panels 89 ft. 4 in. long so that there are about nine panels of each blend of each brand of portland cement. For each of these brands of portland cement there are six variations in the blending; one with seven bags of the portland cement without admixture; one in which one 80-lb. bag of natural cement was used with six bags of portland; one in which one 94-lb. bag of natural cement was used with six bags of portland; one of seven bags in which 5/100 of 1 per cent of vinsol resin had been added per barrel of portland cement; and two others in which portland cement with the resin admixture was blended with one 80-lb. bag and one 94-lb. bag, of natural cement respectively, as in the second and third methods of blending above.

The normal mix used for each seven-bag batch included 1,344 lb. of sand and 2,394 lb. of crushed stone coarse aggregate. The latter was composed of 1,077 lb. of #1 and #2 stone mixed, and 1,317 lb. of #3A stone. The same source of aggregates was used throughout the entire paving on the contract. The amount of mixing water used was about 5 to 5¼ gals. per bag of cement with the normal portland, this amount being reduced about ½ gal. per bag of cement containing the vinsol resin admixture. These figures include the amount of moisture in the aggregates.

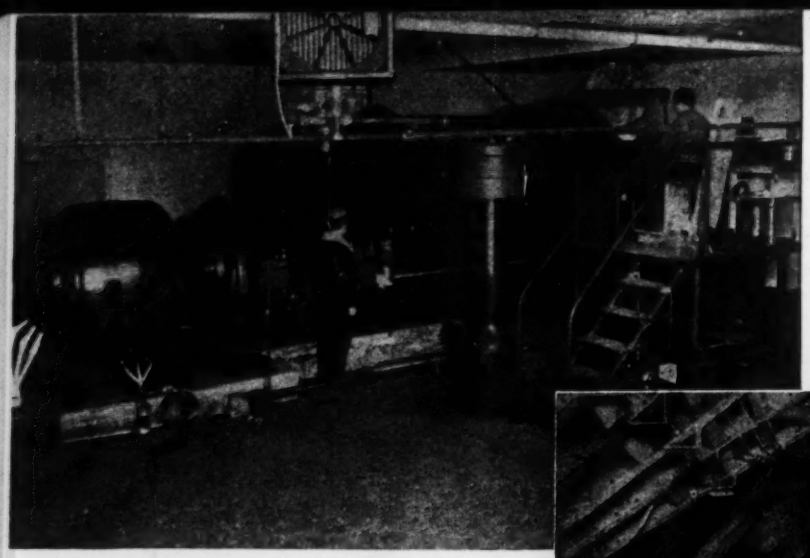
The Portland Cement Association cooperated with the state highway department in keeping careful checks on the mixing and placing of the concrete in the pavement, maintaining a representative on the job while concrete was being placed.

Construction of the relocated section back of West Point was started in the fall of 1939 and the highway was opened to traffic on Sept. 26. The connecting sections to the north and south will not be opened until early next year.

The 5.25-mile section of highway described herein was built by the New York State Department of Public Works, Arthur W. Brandt, superintendent, H. O. Schermerhorn, highway commissioner, James S. Bixby, district engineer and Daniel W. Brown, engineer-in-charge. The Portland Cement Association was represented first by Albert G. Timms and later by H. W. Wilson. The contractor was the West Shore Concrete Co., Suffern, N. Y. The total cost exclusive of land was about $1,800,000, as compared with $900,000 spent on the original Storm King Highway which the relocated section replaces.



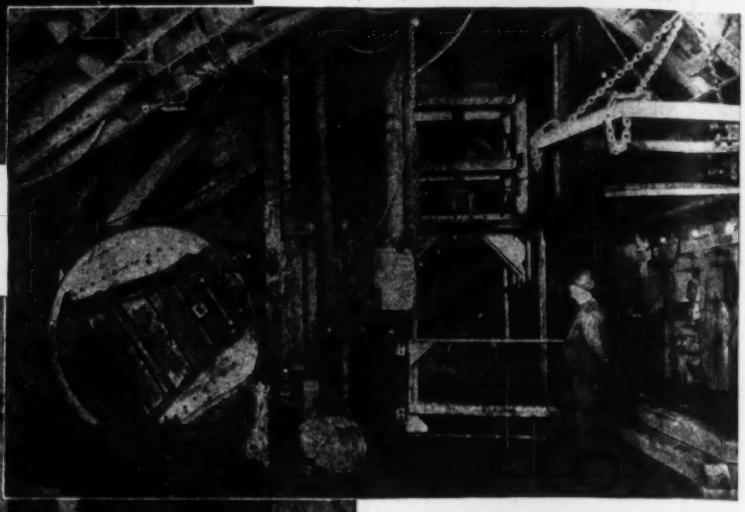
In addition to heavy brooming, grooves are pressed into the surface of the concrete on all grades of 7 per cent or over. The top views show the grooved concrete and the device for making the grooves. The lower picture shows one of the premolded expansion joints. Its novelty lies in the cast iron support, the upper arm of which is buried in the concrete while the foot that extends under the premolded filler is protected from being seized into the concrete of the adjoining slab by a thin metal cover.

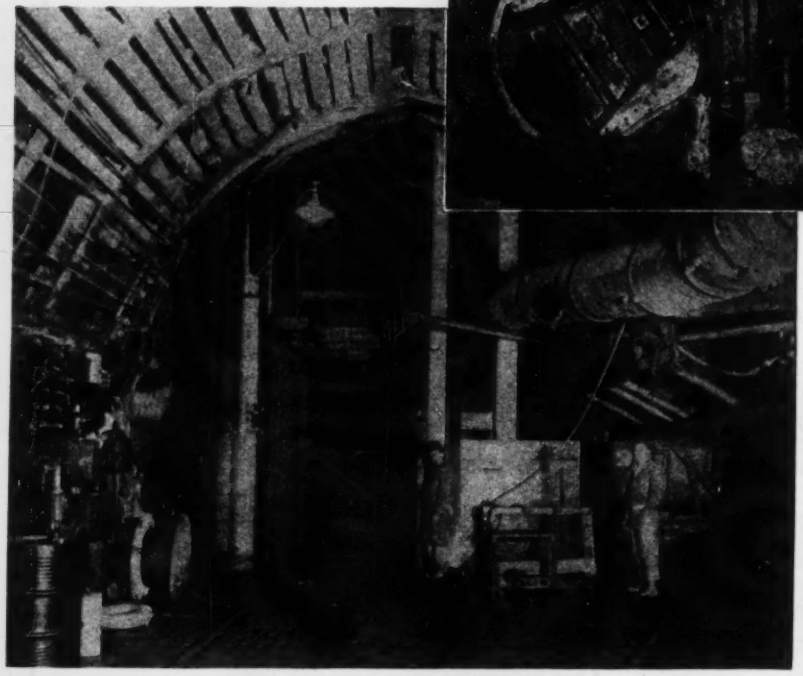


All Photos Board of Water Supply

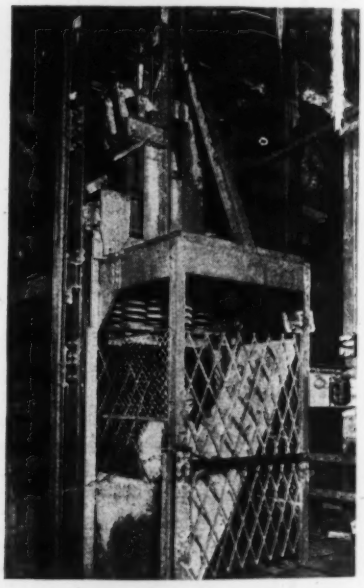
Mine hoist at Shaft 2A, deepest on the Delaware Aqueduct, 1,550 ft.

(Below). One of three typical arrangements at shaft bottom shown on this page. Healy's rotary car dumper at Shaft 15, dumping into skip below tunnel level.

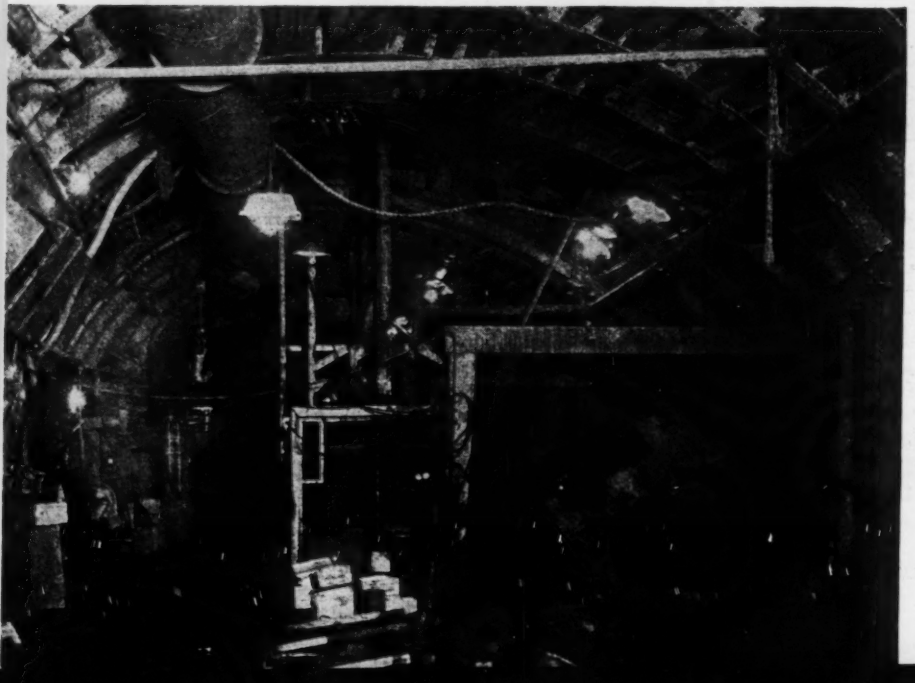




(Left). Associated Contractors at Shaft 17 downtake dumped from spur track into skip in separate hoistway balanced by cage.



Safety dogs that grip the guides in case of accident to cable or hoist are found on every installation. This is a close-up view of the dogs on the cage at Shaft 2.



(Left). Typical of many shaft bottom layouts is Utah's Shaft 12, where the cars dump from run-around track into skip below cage.

DELAWARE AQUEDUCT VII

Tunnel Haulage and Hoisting

***Contents in Brief**—Driving 85 miles of tunnel from 25 shafts requires a lot of hauling and hoisting. The ten contractors on the Delaware Aqueduct have developed and installed heavy and efficient hauling and hoisting equipment for high-speed muck and material handling. This article continues the series describing design and construction of the aqueduct appearing in ENR April 11, p. 513; April 25, p. 584; May 9, p. 656; June 6, p. 797; July 18, p. 109; and Aug. 29, p. 288.*

BECAUSE EVERY CUBIC YARD of muck, every pound of steel roof support, all dynamite, pumps, drill steel, track equipment, drills, piping, jumbos and cars on the 85 miles of tunnel on the Delaware Aqueduct must be handled through deep shafts and headings up to 2½ miles long, haulage and hoisting are vital operations in each of the eleven contract sections. High-speed track, diesel locomotives and new type muck cars are haulage features. Some contractors have adopted new hoisting equipment used for the first time on tunneling. The various arrangements of hoists, skips, cages and counterweights are of special interest.

Trackwork

On most of the jobs the track is built for high-speed service. On all except two contract sections, those of S. A. Healy Co., the track is 36-in.-gage, in 40, 50, 56 and 60-lb. weights. Healy installed 30-lb. rail in a 24-in.-gage track, with metal ties. This light track proved difficult to maintain under the heavy hauling, and derailments are rather frequent. Frazier-Davis has one of the best tracks on the entire aqueduct, 36-in.-gage, 50-lb. rails, laid to exact line and grade on wood ties for use in subsequent concrete lining operations, in which the arch is to be poured ahead of the invert. Passing tracks are provided every 2,000 ft. Red lights indicate the location of switches, so the dinkey operators have advance warning to slow down.

Dravo, Walsh and Shea-Kaiser also have exceptionally good track through the use of 60-lb. rail. Rosoff uses 56-lb., and all others use 50-lb. rail. Experience on the aqueduct proves the worth of heavy rail and well-maintained track for haulage at high speed.

Rosoff, Pleasantville and Dravo are driving headings on 1.85 to 2.30 per cent grades. At regular intervals on open track, and near switches and other stopping points Rosoff and Dravo have installed sand troughs along the outside of the rails. These are set against the rail, flaring upwards. The vibration of passing trains shakes dribbles of sand onto the rail, enough to insure traction and braking resistance. Pleasantville tried but abandoned this method, and their dinkey operators now sift sand by hand through a pipe to the rails. On steep grades Rosoff and Dravo use derail switches at about 500-ft. intervals. These derails pass light trains going up, but are kept open against loaded trains going down. Pleasantville's dinkeys are equipped with dynamic brakes in addition to hand brakes.

Locomotives

Storage battery locomotives, up to 13 tons weight, predominate on the aqueduct. However, two contractors use trolley locomotives and one has a diesel underground. Many contractors use automatic couplers on all train equipment, others use safety pin couplers that prevent smashing of fingers. The old link and pin coupling is rare. Frazier-Davis, in interest of safety, has equipped all dinkeys with big gongs that can be heard above tunnel noise, and strong lights mounted high above the battery box.

Dravo uses a 14-ton diesel dinkey in each heading for the long haul between face and shaft. They operate at high speed under heavy loads, and no trouble has been experienced with the exhaust fumes, as 12,000-cfm ventilation air is supplied to each heading and the diesels are kept "tuned up."

Walsh uses combination storage battery and trolley locomotives. The trolley line, carrying 250 volts d.c., is installed only in the first mile of heading from the shaft, beyond which the dinkeys operate on storage batteries. This is really a safe arrangement, for the trolley is installed only in that part of the tunnel in which driving operations have been entirely completed. The dinkeys, equipped with separate motors for the trolley current, are faster and more powerful in the trolley areas. The motor-generator set for converting the a.c. to d.c. current is located on the surface.

Shea-Kaiser uses trolley dinkeys throughout. Locomotives include combination battery and trolley units, for operating beyond the trolley wire, which, of course, cannot be carried right up to the face, and several dinkeys with trailing leads for working a short distance away from the trolley. After each heading has passed 7,500 ft. in length, a motor-generator set is placed underground that distance from the shaft, converting 2,300 volt a.c. to 250 d.c. current, thus reducing transmission losses. An unusual feature of this installation is the use of the welded-joint vent pipe as the ground return.

Some contractors have battery charging stations underground, eliminating hoisting of the locomotives to the surface. Rosoff uses a mercury rectifier for generating the d.c. cur-

rent for charging the batteries; others use small rotary converters. A monorail hoist, hanging from the roof, transfers the batteries between locomotives and platform charging stations.

Muck cars

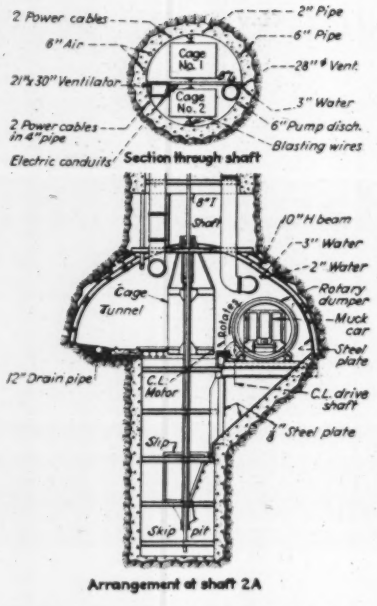
Muck cars vary in size and type. Dravo designed and built their own cars, 5-yd. capacity, one-way dump, with smooth sides to reduce accidents. Rosoff had cars built to their own smooth-side design. These are non-dumping, as Rosoff dumps the cars into skips at the foot of the shaft by means of a rotary car dumper. Seaboard uses 4½-yd. non-dumping cars, hoisting them to a tipple above ground level, where they are emptied by a rotary dumper. Healy uses non-dumping cars of trapezoidal section with rotary dumpers, not only at the bottoms of the shafts, dumping into skips, but also at the tops for cars hoisted on the cages. All other contractors use 3½ to 6-yd. side-dump cars tipped by a cable hook on a hoist or by air rams.

Headframes and hoisting

All headframes are steel, varying from 65 to 150 ft. in height, the higher type predominating. Seaboard, Shea-Kaiser and Associated (at only one of their 4 shafts) hoist cars to the surface and dump from tipples; on all other jobs the muck is dumped from skips into bins having 100 to 150-yd. capacity, and air-operated gates for truck loading.

Because the hoisting arrangements vary so greatly and every type is of interest, a brief description of each contractor's installation will be given, starting at the north end of the project.

Samuel R. Rosoff, Ltd.—At Shaft 2A, the deepest on the project, 1,550 ft., Rosoff has installed a 700-hp electric hoist on the ground, equipped with 1½-in. cable running at a speed of 1,000 ft. per min. Operating in the shaft are two cages, with 7-yd. skips below the cages on the same frame. The two sets of cages and skips are connected to counterbalance; one goes down while the other goes up. The skips dump automatically into hoppers when raised to a certain height on the headframe. At the bottom the skips rest in pits deep enough to bring the cage floor even with the tunnel track level. Cars are dumped into the skip by an electric-



Arrangement at shaft 2A

Rosoff uses rotary dumpers at Shafts 2, 2A, and 3 with two cage-and-skip units balanced in each shaft, differing from Healy's independent skips.

operated rotary car dumper. The installations at Shafts 2 and 3 are similar except the dumpers are air-actuated, cable-operated and dump toward the shaft directly into the skip. Also 500-hp hoists are used as the shafts are not as deep and hoisting speeds of 450 and 750 fpm respectively are satisfactory.

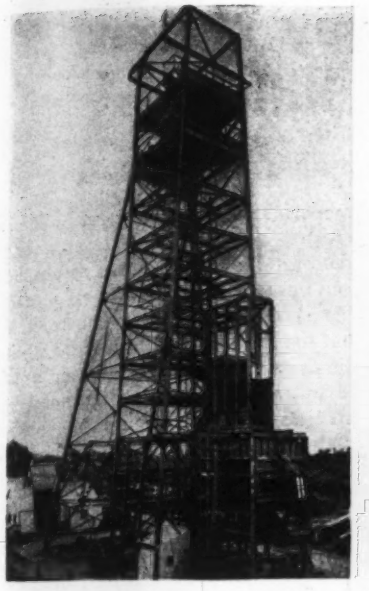
Walsh Const. Co.—At Shafts 4 and 5, Walsh has installed a single cage with a 12-yd. skip underneath, both of aluminum alloy to reduce weight. They are balanced by a counterweight 7½ tons heavier than the empty cage and skip. A 600-hp hoist is set on the ground. Two 2¼-in. cables, one from the counterweight and the other from the cage and skip, are dead-ended on the 8-ft. drum of the hoist; one unwinds while the other winds up. Rope speed is 750 fpm. Cars are dumped into bins below track level at bottom of shaft, which means the skip pit is unusually deep. The bins are fitted with air-operated gates.

Pleasantville Constructors, Inc.—Hoists with 350-hp motors are placed on the ground at Shafts 5A and 6. The shaft arrangement is a cage counterbalanced by a 12-yd. skip in separate hoistways, each handled by a separate 1¾-in. cable dead-ended on the hoist drum. A small counterweight fastened directly to the cage over sheaves in the headframe makes up for the difference in weight of cage and skip.

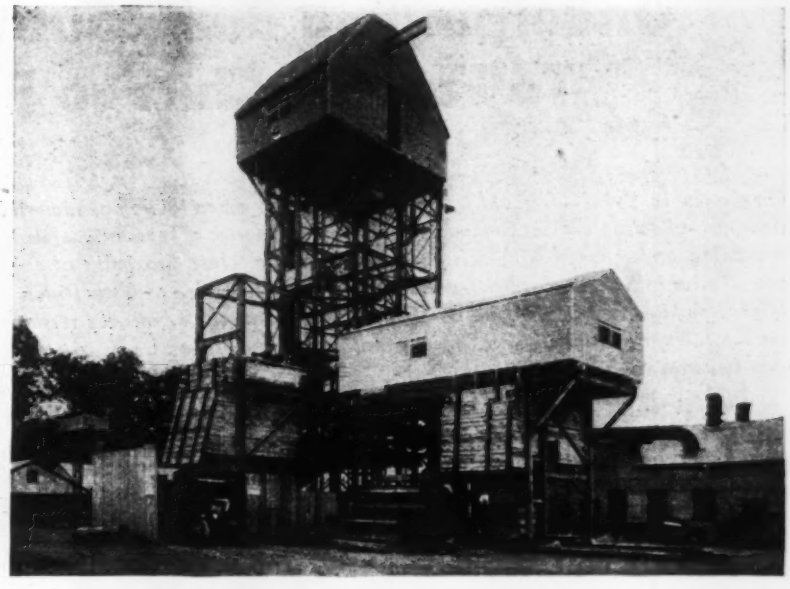
Dravo Corporation—At Shafts 7 and 8 are the most elaborate hoisting arrangements on the entire project. The hoists were designed and built by the contractor and included radical changes which later had to be modified by partial rebuilding at the shafts. However, they are now working according to plan and are entirely satisfactory. The general arrangement is a 400-hp two-drum hoist, on the ground, each drum handling one of two cage-and-skip units in each shaft. The skips, 6-yd. capacity, are carried under the cages. Hoisting rate is 500 fpm using a 1½-in. cable. Through reducing gears and flexible air pressure clutches the hoist can be operated from one motor to balance the two cage and skip units (normal operation) or either unit may be hoisted or lowered independently, or both may be raised or lowered together. This last arrangement is used for handling long locomotives, drill steel cars, or other equipment that is too long for one cage. Also, in case of emergency, the entire underground crew can be brought to the surface at one time. Special safety provisions, for use if tension on the hoist cable is released for any reason, decelerate the cage at speeds commensurate with the distance from the bottom of the shaft.

Dravo also uses a smaller hoist operating in the shaftway outside of cage areas for handling materials without tying up the main hoisting facilities.

Frazier-Davis Const. Co.—Only one of each of the double shafts at 9 and 10 are used for major hoisting. The general arrangement at each shaft is two sets of cages, with 7-yd. skips below, in balance. A 250-hp hoist is on the ground at each shaft, equipped with herringbone reduction gears. The cable is 1⅜ in. Separate lines from each of the two sets of cages and skips dead-end at the drum. At Shaft 9, where the cages are in the downtake shaft, the uptake shaft is used for materials only. A light headframe and a 125-hp hoist handle materials on a single line only; no cage or skip is used. At Shaft 10, where the downtake shaft is entirely out of service, a small hoist handles materials in a separate shaftway outside the guide frame of the uptake shaft. This hoist line operates through a sliding guide frame as a safety feature.



This is Pleasantville's Shaft 5A, typical of balanced cage and skip layouts.



Healy used independent skip and cage elevator hoists mounted at top of headframe at Shafts 15, 16, 20 and 21.

Dravo installed the most elaborate hoists on the whole project, requiring two muck bins at each headframe.

Utah Const. Co.—At Shafts 11 and 12 are 250-hp hoists, on the ground, using 1⅛-in. cable. The shaft arrangement is two cages with 5-yd. skips below, in balance. A separate 150-hp material hoist operates in the small remaining space outside the cage guides in the 14-ft. shafts.

Seaboard Const. Co.—Muck cars are hoisted to a tipple above ground level for dumping on this job, which includes Shafts 13 and 14. A single cage, direct-balanced by a counterweight on a two-part line to reduce counterweight travel, is handled by a 250-hp hoist on the ground. Both the main and counterweight ropes are 1⅛-in. cable. At the tipple an electric car pusher shoves the car into a rotary car dumper for discharging into a truck-loading bin.

S. A. Healy Co.—The hoisting arrangement on Healy's two jobs, at Shafts 15 and 16, and Shafts 20 and 21, are identical. They are radically different from other installations in that they are really elevator and not mine hoisting equipment. On top of the headframe at each shaft are two elevator hoists, independently operated by pushbutton control and having no connection with each other. A 150-hp hoist, with a capacity of 21,600 lb., handles an 8-yd. skip that takes two carloads of muck. A rotary car dumper at bottom of shaft dumps the muck cars. Running in separate guides is a cage for men and cars, handled by the second hoist, 100-hp, 8,500-lb. capacity. Neither skip nor cage is counterweighted but operates through an 8-part hoist line, which means the small motors have ample capacity for the loads involved.

Associated Contractors, Inc.—At Shafts 17 and 19 (no tunnel is being driven from Shaft 18), Associated has installed a separate head frame and hoist for each shaft of their two sets of double shafts, or four in all. At 17 uptake and at 19 uptake and downtake a 300-hp or 400-hp mine type hoist was installed on top of the headframe; at 17 downtake, which is about 1,020 feet deep, a 500-hp standard hoist was set up on the ground about 200 feet from the headframe, because of the large-size hoist-drum required for the length of cable needed. At 17 uptake the shaft arrangement consists of one cage counterbalanced with a 10-ton steel block, and the loaded muck cars are hoisted on the cage to a tipple above ground level. At the other three shafts the muck is hoisted in a 6-yd. skip which operates in its own guides and counterbalances the cage. Aside from the saving of working space, Associated liked the idea of the direct pull of overhead hoists.

Shea-Kaiser—The overhead type of installation is also used on Shafts 22, 23 and 1A north, but here 300-hp hoists on top of the headframes handle cages only. Hoists operate at a line speed of 1,000 fpm, but as a two-part line is used, the cage speed is 500 fpm. The cage takes one 6-yd. car, which is moved off and on the cage by a small air hoist and line. The tipple and 100-yd. storage hoppers are enclosed in soundproof buildings, as these shafts are in thickly populated, residential areas.

The directing personnel of the New York Board of Water Supply and all contractors were given in the previous article of this series (*ENR*, Aug. 29, 1940, p. 288).

Underpinning Beats Subway Threat To Famous Chicago Building

***Contents in Brief**—The old 17-story Monadnock office building, highest bearing-wall structure in Chicago, is carried on floating foundations that are being underpinned with caissons because of the close proximity of the new Dearborn St. subway. Brick piers and combination brick and steel piers, loaded as high as 900 tons, are carefully picked up through grillages resting on the foundation mats while Chicago well caissons are sunk 60 ft. to hardpan beneath the piers.*

ARCHITECTS who built the famous old Monadnock Building in Chicago, engineers representing the owners, and other engineering consultants were of the unanimous opinion that the two shields boring their way down Dearborn St. for the city's new subway could not pass the building without damaging or endangering the structure. Thus advised, the owners felt that they could not risk the subway causing settlement of ground under the floating foundations of Chicago's highest wall-bearing structure, which might result in partial or complete collapse of the 17-story building. Consequently, the front row of piers along Dearborn St. is being picked up by jacks on grillages while Chicago-type well caissons are sunk to hardpan directly beneath the piers, after which the building load is transferred to the caissons.

Fig. 1. Fifty-year old Monadnock Block which is being underpinned as a result of Chicago subway construction.

In view of the character, age and loading of the Monadnock Building, the job is one of the most interesting underpinning projects ever carried out in Chicago. Experienced shoring contractors are doing the work with careful and skillful operations that represent the highest type of foundation procedure. Every precaution is taken to insure the safety of the building, its occupants and the workmen.

Load-bearing walls on mats

The Monadnock Building occupies the entire block bounded by Dearborn, Van Buren and Federal streets and Jackson Blvd. It is 66x400 ft. in plan, the long dimension facing on Dearborn and Federal streets. It was built in four sections, each about 66x100 ft., with load-bearing brick walls and load-bearing partitions between sections. Each section was built for a different owner, but later they were combined in operation. The north half, first to be built, is of wall-bearing type, and is probably the highest building of the type ever constructed. The south half has self-supporting outer walls, but the floor loads are carried by steel column in the walls, reflecting the beginnings of the skyscraper.

The two north sections, 16 stories high and designed by Burnham & Root, were completed in 1892. Two years later the 17-story south half, of somewhat different architecture, designed by Holabird & Roche, was completed. The Monadnock Block, rising 216 ft. above the curb, is the tallest bearing-wall office building ever built, and constitutes an important link in the development of the modern skyscraper. Several buildings erected on Dearborn St. at a later date are being torn down as obsolete and not worth the expense of protecting against the subway construction, but the Monadnock Building, with its fundamentally correct design as to layout and column spacing, has been able to survive because of careful maintenance and extensive modernization.

Foundations for all sections consist of concrete-encased steel grillages, averaging 5 ft. thick, forming odd-size mats. In the north half the grillages are seven tiers of railroad rails, each tier laid at right angles to the one above and below. Beneath the bottom tier is a layer of unreinforced concrete to make up the 5-ft. depth of mat. The foundations on the south half are similar, except that five tiers of 12-in. I-beams were used instead of rails. The steel tiers taper off in length from bottom to top, forming a stepped foundation. There is no uniformity to the size or position of the mats; they each carry from one to five piers and bearing walls and in the aggregate take up practically all of the foundation area.

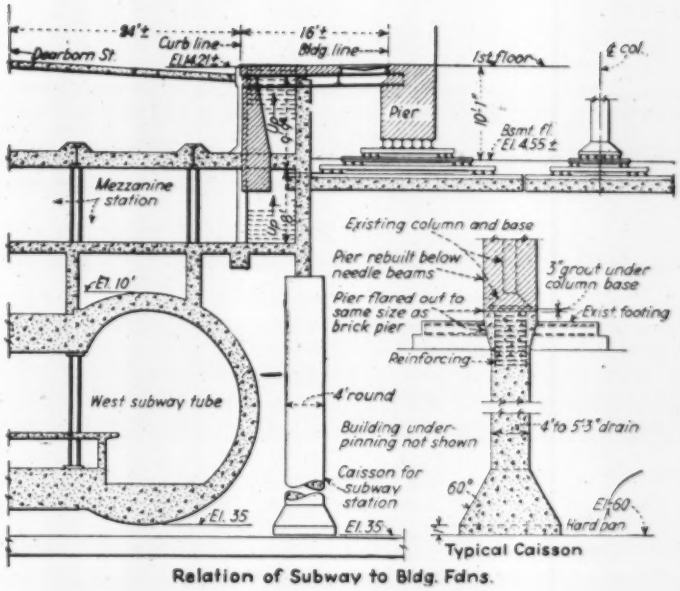
The mats rest on the Chicago blue clay at about El. 0.0 (city datum) or some 15 ft. below street level. Top of mats are at basement floor level. From old drawings and from running out the loads from top to bottom, the architect determined the loading on each pier and column, and found the mats exert a soil pressure from 3,300 to 5,700 lb. per sq.ft., though the average is 3,500 lb., which is considered proper even today for the Chicago blue clay.

Supported by the mats are two types of piers: rectangular solid brick masonry piers, ranging from 5x5 ft. to 8x9 ft. in size; and a combination of steel columns and brick piers. These columns are built up sections of Z-bars and plates, encased in brick masonry which carries part of the load. In addition to the piers are four cross walls, load-bearing, carried on large mats. The brick masonry is of most excellent quality, in fact the bricks are so hard and the mortar

bond so tight that pneumatic chisels are necessary to remove the masonry. Loads on the piers and columns vary from 387 to 917 tons.

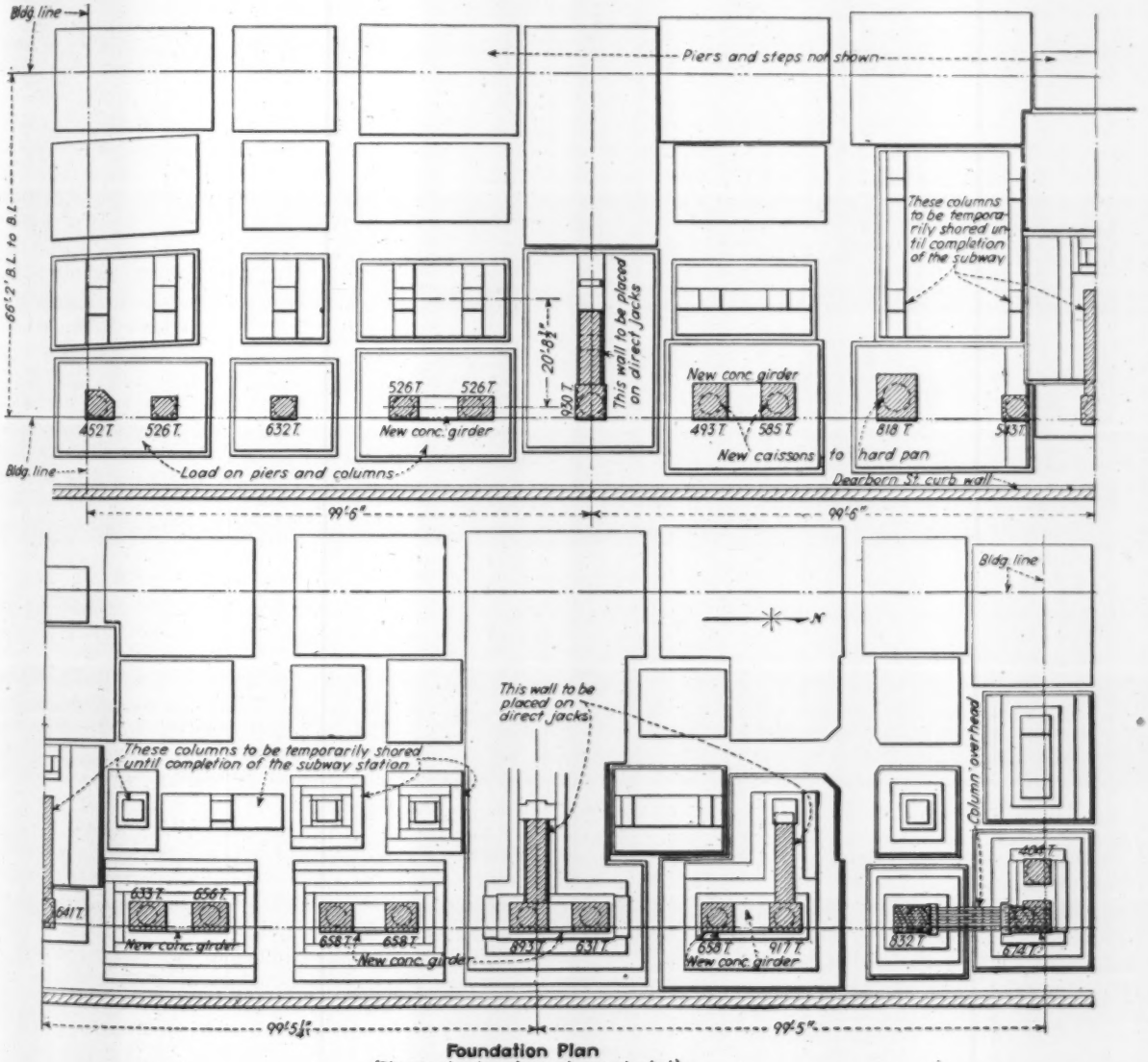
Subway below foundation level

As shown in Fig. 2, the west wall of the west shield-driven subway tube lies only 3 ft. outside of the east line of foundation mats. Top of subway tube is about El. —10; bottom is El. —35. For a length of 103 ft. alongside



Relation of Subway to Bldg. Fdns.

Fig. 2. Plot plan (below) showing foundations being underpinned and their loads; south half of building is on top with north half placed under it. Design of a typical underpinning caisson is shown at right; also relation of new subway structures to the old building foundations.



Foundation Plan
(Piers underpinned are shown shaded)

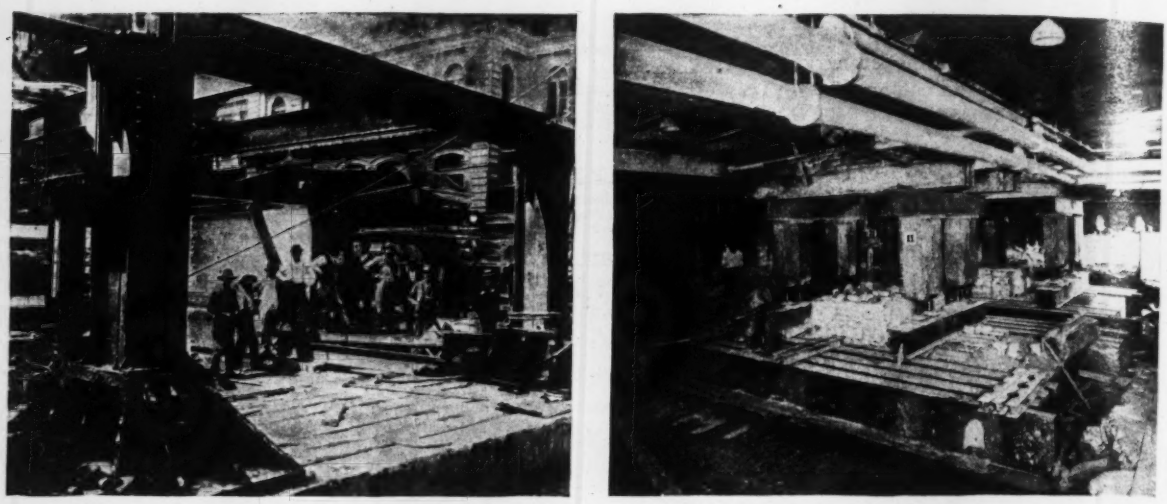


Fig. 3. Taken 50 years apart, these views show the original Monadnock construction and its underpinning today.

the center portion of the building will be a mezzanine subway station, to be built in open cut. The west wall of the station cuts through the building foundation mats, and supporting this wall will be three caissons sunk to El. —55.

It was decided that only the front row of 21 piers, under the Dearborn St. building line, resting on 13 mats, would have to be underpinned, providing the work was carefully done. In addition, one pier on the Jackson St. end, resting on a common mat with the northeast pier, is being underpinned. Where load-bearing cross-walls frame into the piers they are picked up with the piers, but not underpinned. Six piers on the second, or first interior, row opposite the station will be picked up on hydraulic jacks to compensate for any settlement during subway construction, but will not be underpinned.

The design for the underpinning calls for a Chicago well caisson to be sunk under each pier, carried to hardpan, about El. —60. Caissons are 4 to 5½ ft. in diameter, and bell out at the bottom from 9 ft. 3 in. to 13½ ft. in diameter. In six cases where two piers rest on a common mat, a heavy reinforced-concrete girder is built between tops of caissons and the piers, the two caissons jointly carrying the two piers.

The shoring and picking up of the piers is a remarkable job. Each pier is picked up through a grillage resting on the mat. This does not increase the unit soil pressure appreciably, as the hole later cut through the mat for digging the caisson is small in area as compared with the full mat area. Shoring procedure differs somewhat on the all-brick piers and the combination steel and brick columns.

Fig. 4. There is no loss of ground in sinking these Chicago well caissons, for the lagging is forced out into the clay by jacks and half-moon drums, while steel wedges are driven into the ring joints to expand the rings tight against the lags.

Shoring the brick piers

On the brick piers the first operation is to place a set of four or five I-beams, usually 15-in. 42.9-lb., on one of the lower steps at each end of the mat across the narrow dimension. Then, on top of these two sets of beams, placed in longitudinal direction on each side of the pier, are two sets of four 15-in. 60.8-lb. I-beams. Beneath this second set is placed a concrete pad to provide full bearing on the mat.

On top of the second beams are placed short 4-in. I-beams in pairs, cut out to receive 3-in. screw jacks. A sufficient number of jacks is used to bring the load on each down to 10 tons, as this weight can be handled easily. On top of the jack is placed 3-in. maple blocking. Another set of 15-in. beams, known as the caps, is then set directly over the second set of beams, resting on the maple blocking. Spanning between the sets of cap beams are the needles, usually 24-in. 106-lb. I-beams.

The needles are placed with no load on the jacks. They are usually set a pair at a time, started by cutting out a chase along one side of the brick pier. When the first set has been installed, very dry grout of high-early-strength cement is packed above, below and between the beams and rammed tight by pounding with poles and sledge hammers. The grout is allowed to set before the cut is made for the next pair of needles. Needles are placed flange to flange, full width of the pier. Thus, the needles and their grout packing eventually replace a full section cut out of each pier. As an added precaution timber struts are placed between piers above the level of the needles, wedged tight to stiffen the pier system. Other safety features are clamps around the cap beam sets to prevent possible spreading and four heavy tierods through each set of needle beams.

To lift the pier free of the foundation, the jacks are turned one at a time, working in rotation around and around the pier. The maple blocking forms a cushion that makes this procedure possible, for if it were not for

the compression of the wood fibers, it would be impossible to turn the jacks one at a time. Also, a crew of as many as 60 men would be required to turn all jacks simultaneously, an impossible procedure, because the position of the jacks is such that turning bars would interfere with each other. Jacking is continuous until the pier has been lifted ⅛ in. Where a crosswall joins a pier, the wall is picked up by needles and is lifted with the pier, though only for ⅛ in. Level readings are taken every 4 hr.

Fig. 5. Cutting out a steel base of a combined steel and brick pier. Note the rail grillage incased in concrete. Over the heads of the workmen are the needle beams supporting the brick part of the pier.

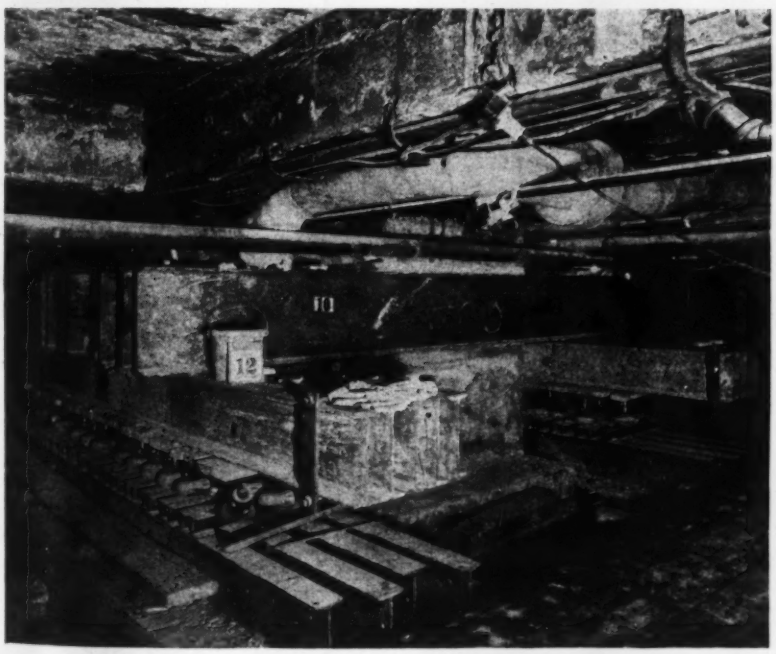


Fig. 6. Typical shoring arrangement for picking up an all-brick pier. Needle beams have been grouted in place; the assembly is ready for jacking and removal of pier below needles. Another row of grillage beams, not visible, is under the ends of the beams in the foreground.

on all piers under treatment to determine any possible settlement.

Picking up combination piers

On the combination steel column and brick piers the general procedure is the same as outlined above, but details vary. The brickwork is supported on needles and the temporary jacks, then the masonry between bottom of needles and top of mat is stripped away from the column. Tack welds are made to join the Z-bars and plates so the old rivets can be backed out to permit riveting lifting plates and angles to the columns. Two 4x12-in. and two 4x14-in. billets are set up as needles to carry the steel column, the latter two being placed through the column webs. The combination of billets and needle beams supporting the brickwork is then picked up by a jacking system similar to that on the all-brick piers.

A special needle system is required on the northeast pier. Here, evidently to provide vault space for an early bank tenant, a column is carried on a series of beams at main floor level, the beams being supported by walls of steel plates stiffened by angles resting on the mats. This arrangement will not be disturbed, except to be strengthened, but a special needle system where the needle beams frame into 36-in. beams outside the pier is necessary.

Caisson sinking

After a pier is picked up, the portion remaining below the needles is removed, along with the top layer of foundation steel grillage if possible. Then a hole, slightly larger than the caisson diameter, is cut through the mat by burning out the steel and chipping out the concrete. This hole is flared at the top to take the transition from the circular caisson to the full size of the rectangular pier.

The caissons start at the bottom of the mat. Excavation is in 3-ft. cuts, each cut being lined with vertical 3-in. maple lagging 3 ft. long, braced by two internal rings of ⅜x3½-in. bars, fabricated in two half-sections with bolted joints. From a depth of 36 ft. to the bottom, 4-in. channels are used for rings instead of the bars. Extreme care is taken in digging the caissons to keep the excavation slightly under size. After a set of lagging is placed, it is necessary to drive the rings into place because of the scant excavation. This pushes the

lagging out into the soil, but not enough to satisfy the contractors. After each ring is in place—and here is the secret of caisson digging without loss of ground and settlement of the mats—two half-moon wooden drums are jacked against the lagging, and steel wedges are driven into the ring joints to force the steel tight against the wood. Prior to the drum jacking, wood shims are driven between the steel rings and wood lagging to bring the steel into bearing against each lag. The jacking compresses the lagging well into the soil, removing all voids that might have been left from the digging. The jacking process is repeated as each supporting ring is set.

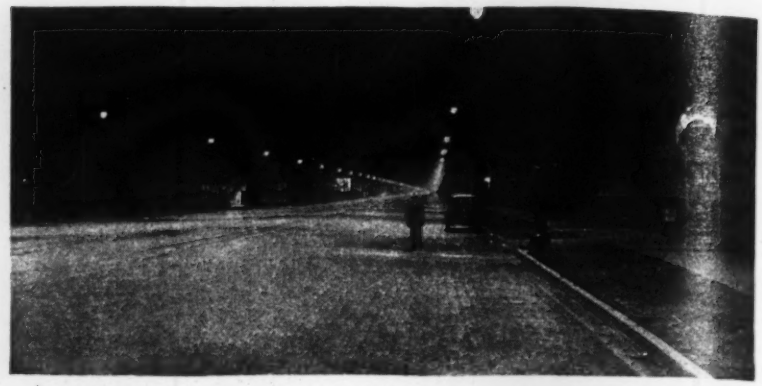
The caissons are sunk to El. —60 and belled out in ten shifts, or $3\frac{1}{3}$ days. In another 4 hr. they are filled with concrete to the top of the mat. Caisson buckets are hoisted by a rope running around a niggerhead on an electric hoist. Muck is wheeled from the caisson to the curb wall, where it is shoveled by stages to street level to be hauled away in trucks.

Concrete of 1:2:3 proportions is mixed in the street by a small mixer. For the bell section the concrete is lowered by bucket, for the shaft it is deposited through a flexible spout. The schedule is to start one or more caissons on Monday morning and complete them by Saturday so no holes will be open over the week end.

From top of caisson to the under side of the needle beams the piers are restored to full size in concrete. Dry grout is rammed between top of concrete and bottom of needles to provide full bearing. After the grout sets, the jacks are released and the needles are burned off outside the piers, the part within the piers remaining in place.

Direction

Aldis & Co., managers of the property since its inception, represent the owners. Holabird & Root, successors to the two architectural firms that designed the original building, are architects on the project, with Verne O. McClurg, chief structural engineer, and C. C. Pennington, resident engineer, in charge. The general contract for the work is held by Carroll Const. Co., Chicago; Frank Carroll, president, is in charge for his company. Gooder-Henrichsen Co., Inc., Chicago, is subcontractor on the shoring and underpinning.



Los Angeles Streets Made Safer By Sodium Vapor Lighting

BECAUSE OF the exceptionally high ratio of motor vehicles to population, Los Angeles has had difficult traffic problems for a long time. In recent years, since special attention has been given to the reduction of traffic hazards, careful analysis of accident records has shown a high percentage of collisions at night. The most effective remedy for this situation was believed to be better lighting. Accordingly, sodium vapor lighting was adopted for important intersections, and with highly satisfactory results.

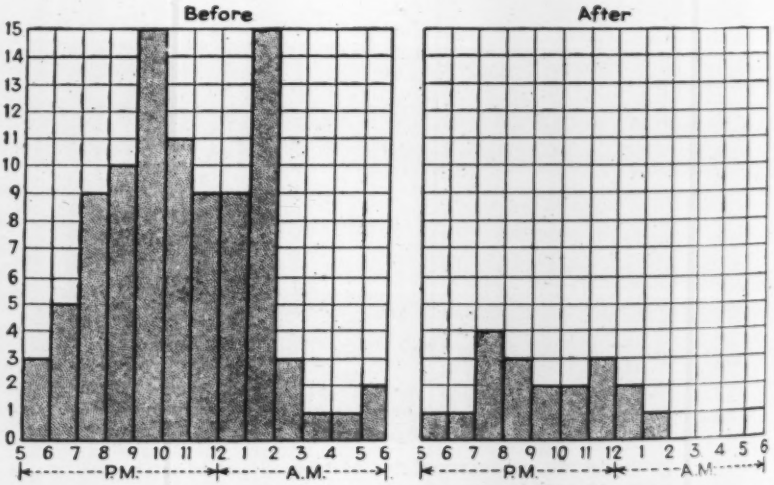
Recent figures give definite evidence of the effect of this lighting on traffic accidents. For 25 street intersections, accident records are now available for a two-year period before sodium vapor lighting was installed and for the same period after installation. The consistently better safety record, as shown by the accompanying diagram, speaks for itself.

The data were compiled by R. T. Dorsey, Los Angeles traffic engineer.

FOUR YEARS OF TRAFFIC ACCIDENT RECORDS AT 25 LOS ANGELES STREET INTERSECTIONS

Two Years Before and Two Years After Sodium Vapor Lighting Installations

	Collisions		Injuries		Fatalities		City Property Damage	
	Before	After	Before	After	Before	After	Before	After
Number of Accidents	91	20	142	30	12	1	14	3
Percentage Decrease		78		79		92		79



Graphic presentation of total number of collisions in two-year period at 25 street intersections (a) before and (b) after sodium vapor light installations.

From Field and Office

Working problems and time-saving methods for engineers and contractors

Load Testing Steel Piles

A method of load testing piles developed by the Georgia State Highway Board bridge department is illustrated below by a test on 10-in., 72-lb. steel H-pile. Two 24-in. I-beams are supported on convex bearing plates, which are in turn supported by angles welded to the sides of the pile. Collapsible timber loading boxes are attached to the ends of the beams at lever arms of 5 ft. 2 in. from the center of the pile. A 100-ton hydraulic jack is mounted on top of one end of the beams in such manner that the loading box directly underneath can be lifted off the ground, whereas the loading box on the opposite end acts only as a deadman.

A calibrated gage attached to the hydraulic jack regulates the amount of loading material in the box. This load is adjusted to half the load desired on the pile and, with the box suspended a few inches off the ground, is left for the duration of the 48-hour test. If desired the loading boxes may be replaced with driven anchor piles for the deadman or suspended platforms to load the jack.

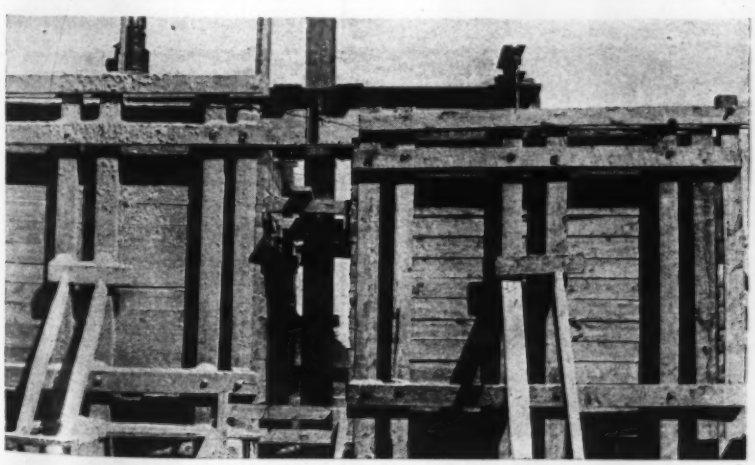
The primary advantages of this apparatus over the loaded platform are: simplicity of maintaining a balanced load; ease of assembly and transportation from one job to another, and application to the jack of only half the desired bearing load on the pile. One other desirable feature afforded is that if one test is completed and does not indicate the specification bearing, the clip angles may be removed, the pile driven to a deeper penetration without disturbing the set-up of the apparatus, and another test applied.—C. N. CROCKER, *Bridge Engineer, State Highway Board of Georgia, Atlanta.*

Water Curing Concrete Floors

On the Frankfort, Ky., Municipal Housing Project floors were cured under water for seven days, at less expense than by sprinkling.

The outside of the slabs was formed with lumber two inches thick, the top being used to strike off the concrete form. As soon as the slab was finished $\frac{7}{8}$x$\frac{7}{8}$ strips were nailed around the outside edge and made watertight by applying a small quantity of lime-sand mortar to the inside edge of the strip and floor. Sleeves in the floor projected above the surface so the water did not run down pipe openings. Larger openings were sealed in a manner similar to that used for the edges.

Where the concrete extended over the wall to form door sills the sealing strips ran across the tops of the sills but the sills were kept wet by covering them with a piece of burlap, one end of which lay over the strip in the water. Capillary action kept the burlap wet—IRA A. BUTCHER, *Lexington, Ky.*



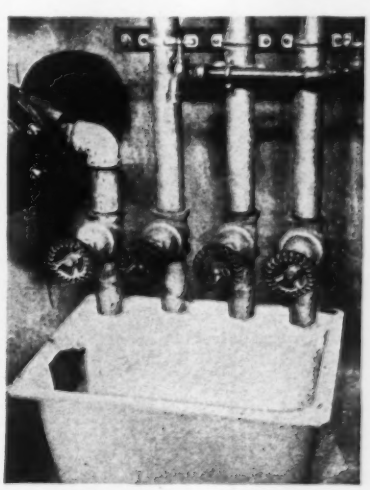
Loading arrangement for testing piles used by Georgia highway bridge department.

Steel Hook to Wreck Plank Deck

A convenient hook for removing the plank decking from a temporary timber trestle built around the Elysium Park slide at Los Angeles was developed by the U. S. Engineer Department. Essentially the device is a $1\frac{1}{2}$-in. round bar bent into U-shape, as shown in the accompanying illustration, with a lug and link-welded to one leg for convenience in attaching the hauling line from a small crane. With this hook, it was found, 2-in. decking planks can be ripped out rapidly in less time and at lower cost than by other methods.

Sludge Sampling Simplified

Four pipes which tap a sludge digestion tank at different elevations make it easy to draw samples and find out what is happening at the Springfield, Mass., sewage disposal plant. (*ENR*, Sept. 26, 1940, p. 38). The pipe at the lower left connects with the suction of the withdrawal



Digestion tank sampling facilities.

pump, so that a bottom sample can be obtained.

The pipes discharge into a sink located on the control floor of the digester building so that they can be drained to obtain a true sample. High above the sink is a water faucet connection which facilitates cleaning the sink after use. Gascoigne & Associates, sanitary engineers of Cleveland, designed the plant.

Windshield for Plumbob

A windshield made out of pieces of scrap lumber is used by the engineers on the new air base at Jacksonville, Fla., to shield the plumbob of their transit when setting up over an exposed point. A three-sided box high enough to protect most of the plumbline is equipped with two long base strips that give the box stability to stand up in a strong wind.

Erasing Ink From Photographs

With the increasing use of aerial photographs for mapping and planning purposes, the draftsman is at times confronted with the problem of making erasures and corrections of information previously inked on the photographs.

Very satisfactory erasures can be made by barely moistening a piece of clean linen held over the end of the index finger and gently rubbing the inked portion that is to be removed. This rubbing causes the ink to smear and to come off on the cloth. By barely moistening new spots of the linen successively as needed, it is possible to clean the photograph so that no trace of ink is left.

An erasing shield is of great assistance in removing ink from closely inked areas. Care should, however, be taken quickly to blot up the moisture that may collect under the shield with an ordinary white blotter so that other parts will not be moistened and smeared.

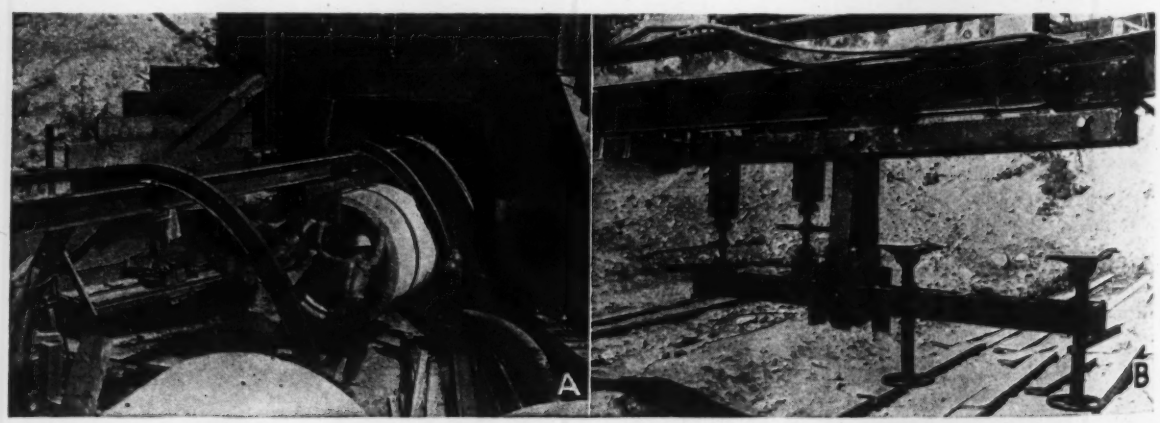
No trouble is had in inking over areas which have previously been inked and erased. — HOMER W. KRATTLY, *Russellville, Ark.*

Pipe Telephered into Tunnel

In laying a 48-in. concrete sewer pipe through the Dayton Ave. tunnel at Los Angeles, clearances were limited and working space was at a premium. Under these conditions, the contractor found advantage in using an overhead rail or telepher, slung from steel ribs of the temporary lining, for delivering and placing the pipe sections. By a convenient arrangement of the carriage on which the pipe sections were conveyed, it was possible to make slight adjustments in the position of a section as it was being unloaded, thus materially aiding and speeding the operation of fitting it into the adjoining section already in place. The angle of presentation could be changed by hand wheels on threaded shafts at both ends of the carriage. The overhead rail was found more convenient than the usual invert track and was used for hauling out cars of muck as well as for placing the pipe sections.

Muck Bucket From Oil Drum

A bucket convenient for removing small quantities of muck and other debris from a deep, narrow cutoff trench in the Prado Dam spillway, was built on the job by welding reinforcing steel to an oil drum as shown in the accompanying picture. The bail, also made of reinforcing steel, was twisted to form a central loop, thus preventing any tendency to slip on the hook of the hoisting rig.



Telepher does hauling in Los Angeles sewer tunnel. (A) pipe loaded and entering the tunnel portal; (B) adjustable carriage on which section of pipe is hung.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

Water Supply Engineering

PUBLIC WATER SUPPLIES — Fourth Edition. By F. E. Turneaure and H. L. Russell. 700 pp. Published by John Wiley & Sons, Inc., New York. Price $6.

Compiled by engineers who have a keen appreciation of what engineers expect to find when they consult a book of practice, this fourth edition of "Public Water Supplies" ranks as one of the most useful and comprehensive texts available on the subject.

Much progress has been made in the sixteen years which have elapsed since the previous edition appeared, and the book largely has been revised to include new developments. This is particularly evident in the chapters on pumping equipment, purification practice, distribution system calculations and water quality determination. Appreciating that space is at a premium in a book of this kind, it is nevertheless to be regretted that not more information was included on some noteworthy developments in elevated tank structures and recent aqueduct construction.

Largely Civil Engineering

GENERAL ENGINEERING HANDBOOK —Second Edition. Charles Edward O'Rourke, editor-in-chief, 1,120 pp. Published by McGraw-Hill Book Co., New York and London. Price $4.

Those who had the original handbook prepared by Professor O'Rourke and his co-editors in 1932 are familiar with its plan to center attention on fundamentals and principles. This plan is extended in the new and larger edition. Description of practices and structures, history and the development of formulas have been further reduced and the space gained has been used for additional facts of fundamental character. The pages of the book have also been increased from 921 to 1,120. The parts of the older book that have been eliminated are principally water power plants, mechanical power transmission, electric power equipment, electric power transmission and distribution and welding, except design. Expansion has gone principally into the basic sections on mathematics, materials, mechanics and hydraulics.

About three-fourths of the volume is devoted to civil engineering.

Highway Costs

ROAD AND STREET CONSTRUCTION METHODS AND COSTS—By H. P. Gillette and John C. Black. 607 pp. Published by Gillette Publishing Co., Chicago, Ill. Price, $6.

This is the latest of the series of volumes on construction costs provided by the senior author with various collaborators since the publication a generation ago of his popular "Handbook of Cost Data". Like the previous volumes the book is largely a compilation of costs previously published in official reports, professional papers and engineering journals. The figures are thu of various dates and are sometimes in man-hour units and sometimes direct dollars cost per volume unit. Some are general and some are broken down in great detail. Thus the reader has a book giving a really vast volume of costs that call for keen judgment in their use but, when soundly applied, have value for many purposes. In six chapters the authors explain cost indexes and discuss and give costs of overhead, engineering, right-of-way, equipment and labor. Four chapters follow on costs of functional operations such as clearing, grading, hauling and producing aggregates.

Reinforced Concrete

RECOMMENDED PRACTICE AND STANDARD SPECIFICATIONS FOR CONCRETE AND REINFORCED CONCRETE—Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. 140 pp. Published by the American Concrete Institute, 7,400 Second Boulevard, Detroit, Mich. Price $1.50.

This small pamphlet contains the fundamentals on which all concrete design and construction should be based if it is to meet present-day standards. Beginning back in 1904, committees representing the American Concrete Institute, American Institute of Architects, American Railway Engineering Association, American Society of Civil Engineers, American Society for Testing Materials, and the Portland Cement Association, had studied and recommended to the profession through similar joint committee reports what is the best practice at the time each report is prepared. The current committee was organized in June, 1930, and held its final meeting in June of this year. Covered in the report are materials, proportioning, mixing, curing and testing concrete, forms and placing. Details of design and construction, waterproofing and protective treatments, surface finishes, design and specifications. Obviously, in so small a compass details in such matters as design are not given, the report being limited to setting forth the fundamentals and basic requirements that must go into specifications and design requirements.

Miscellaneous Notes on Booklets and Reprints

NEW COMMERCIAL STANDARDS of practice for pipe nipples made from various metals are described in Pamphlet CS5-40 of the National Bureau of Standards. For sale by the Superintendent of Documents, Washington, D. C. Price 5c.

TIDES AND CURRENTS in the waterways that come under the jurisdiction of the Interstate Sanitation Commission are described in a 100-pp. WPA project report sponsored by the commission. A limited number of copies are available. Apply to Col. Brehon Somervell, Administrator, Works Projects Administration, 70 Columbus Ave., New York City.

TWENTY YEARS OF HIGHWAY RESEARCH is brought together in a bibliography under the title "Highway Research, 1920-1940" prepared jointly by the Highway Research Board and the American Association of State Highway Officials. Subjects are classified and brief summaries are given of each report, book, pamphlet or technical article that is listed. Copies may be obtained either from the Highway Research Board, Na-

tional Research Council, Washington, D. C., or from the American Association of State Highway Officials, Washington, D. C.

ALUMINUM SULPHATE and its use in the purification of water and treatment of sewage is discussed in a booklet prepared by the General Chemical Co., 40 Rector St., New York, N. Y. Copies are free.

CAST IRON PIPE in sewerage systems is the title of a pictorial bulletin showing many interesting installations of this pipe in sewers and sewage disposal plants. Available from the Cast Iron Pipe Research Association, 122 So. Michigan Ave., Chicago.

PROCEEDINGS of the 25th anniversary meeting of the New Jersey Sewage Works Association—where plans were initiated last March for the reorganization of the Federation of Sewage Works Associations—are available for distribution. Copies may be obtained from Paul Molitor, Jr., Box 374, Morristown, N. J., $1.50. Included is a report on safe handling of sludge gas.

GOVERNMENT ACCOUNTING PRACTICES are summarized in three pamphlets put out by the Municipal Finance Officers Association, 1313 E. 60th St., Chicago, Ill., under the titles of "Accounting for Government-owned Motor Equipment," "Accounting for Governmental Supplies," and "Governmental Time Keeping and Payroll Procedure." These pamphlets sell for 50c. each.

MATERIAL DETAILS, a companion book to the Michigan State Highway Department's 1940 Standard Specifications, has just been issued by the department. The new book contains requirements for all materials listed in the standard specifications, and includes specifications for some miscellaneous materials used for maintenance and other general purposes. Copies may be obtained from the Contract Engineer, Room 425, State Office Building, Lansing, Mich. Price 35c.

BUILDING MATERIAL REPORTS recently published by the National Bureau of Standards, Washington, D. C., as additions to the bureau's report on "Building Materials and Structures" include the following: structural properties of "Scot-bilt" prefabricated sheet-steel construction for walls, floors and roofs; prefabricated wood-frame construction for walls, partitions and floors; "Precision-Built" frame wall and partition construction; "Tilecrete Type A" floor construction; effect of ceiling insulation upon summer comfort; masonry wall construction of "Munlock dry wall brick". These pamphlets may be obtained from the Superintendent of Documents, Washington, D. C., for 10c. each.

New Engineering Books

STRENGTH OF MATERIALS—Part I, Elementary Theory and Problems. By S. Timoshenko. Second Edition. 359 pp. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York. Price $3.50.

ROAD AND STREET CONSTRUCTION METHODS AND COSTS—By H. P. Gillette and John C. Black. 607 pp. Published by Gillette Publishing Co., Chicago. Price $6.

COST ACCOUNTING — By John G. Blocker. 705 pp. Published by McGraw-Hill Book Co., New York and London. Price $4.

WHO'S WHO IN RAILROADING—1940, Tenth Edition. 716 pp. Published by Simmons-Boardman Publishing Corp., 30 Church St., New York. Price $7.50.

DETERIORATION OF STRUCTURES OF TIMBER, METAL, AND CONCRETE EXPOSED TO THE ACTION OF SEA-WATER—By J. Newton Friend. 52 pp. Published by The Institution of Civil Engineers. May be obtained from William Clowes & Sons, Ltd., Axtell House, Warwick St., Regent St., W. 1, London. Price 8s 6d. or through the Engineers Book Shop, 168 E. 46 St., New York.

DESIGN OF CONCRETE STRUCTURES —By Leonard C. Urquhart and Charles E. O'Rourke. Fourth Edition. 564 pp. Published by McGraw-Hill Book Co., New York and London. Price $4.50.

TECHNICAL DRAFTING—By Charles H. Schumann. 793 pp. Published by Harper & Brothers, New York and London. Price $3.50.

TECHNICAL DRAFTING—By Frederick E. Giesecke, Alva Mitchell, and Henry Cecil Spencer. Second Edition. 687 pp. Published by the Macmillan Company, New York. Price $3.

WILEY TRIGONOMETRIC TABLES—81 pp. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, London. Price 75c.

THE RIGID FRAME BRIDGE—By Arthur G. Hayden. Second Edition. 285 pp. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, London. Price $4.50.

CITY MANAGER GOVERNMENT IN THE UNITED STATES—By Harold A. Stone, Don K. Price and Kathryn H. Stone. 279 pp. Published by the Public Administration Service, 1313 East 60th St., Chicago, Ill. Price $2.50.

PORT OF CHICAGO, ILLINOIS—Lake Series No. 4. Prepared by The Board of Engineers for Rivers and Harbors. May be obtained from the Supt. of Documents, Washington, D. C. Price $1.

PORTS OF SAN FRANCISCO, OAKLAND, ALAMEDA, RICHMOND, AND UPPER SAN FRANCISCO BAY, CALIFORNIA—Port Series No. 12. Prepared by The Board of Engineers for Rivers and Harbors. May be obtained from the Supt. of Documents, Washington, D. C. Price $1.75.

Reports and Pamphlets

FLOW DATA AND DRAFT STORAGE CURVES FOR MAJOR STREAMS, 1929-1937—Maryland State Planning Commission and Water Resources Commission, Baltimore, Md. Price 50c.

DEFENSE COORDINATION OF THE PANAMA AND FLORIDA CANALS—Senate Document No. 198, 7th Congress, Third Session. Superintendent of Documents, Washington, D. C.

PROGRAMMING PUBLIC WORKS—Tennessee State Planning Commission, Nashville, Tenn. Price $1.

STRESSES IN A CURVED BEAM UNDER LOADS NORMAL TO THE PLANE OF ITS AXIS—Bulletin 145. May be obtained from the Iowa Engineering Experiment Station, Ames, Iowa.

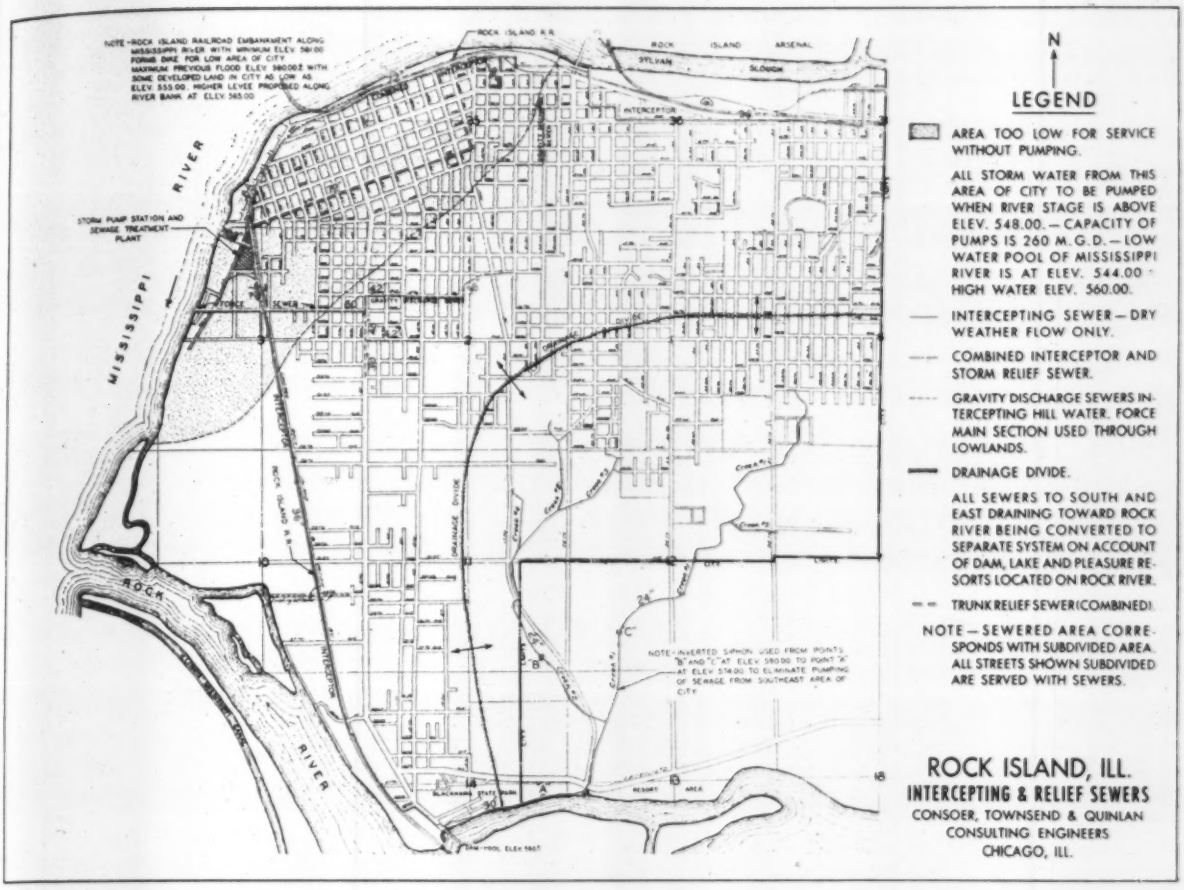
TRANSPORTATION IN 1950—By Chester H. Gray. Published by the National Highway Users Conference, National Press Bldg., Washington, D. C.

FROST ACTION IN HIGHWAY BASES AND SUBGRADES — Research Series No. 73. May be obtained from the Engineering Experiment Station, Lafayette, Ind.

SUCCESSFUL SUBDIVISIONS — Land Planning Bulletin No. 1. Published by the Federal Housing Administration, Washington, D. C.

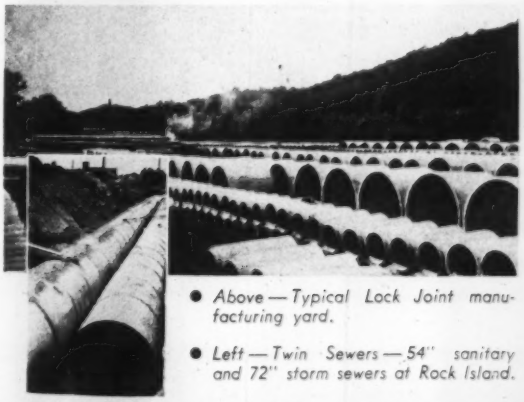
OH SAY CAN YOU SEE?—A Report on New Jersey's State-Wide Safety Lighting Program. Published by the New Jersey State Highway Department. May

(Continued on p. 76)


NOTE - ROCK ISLAND RAILROAD EMBANKMENT ALONG MISSISSIPPI RIVER WITH MINIMUM ELEV. 561.00 FORMS DIKE FOR LOW AREA OF CITY. MAXIMUM PREVIOUS FLOOD ELEV. 560.00 ± WITH SOME DEVELOPED LAND IN CITY AS LOW AS ELEV. 555.00. HIGHER LEVEE PROPOSED ALONG RIVER BANK AT ELEV. 565.00
ROCK ISLAND R.R.
ROCK ISLAND ARSENAL
SYLVAN SLOUGH
INTERCEPTOR
MISSISSIPPI RIVER
STORM PUMP STATION AND SEWAGE TREATMENT PLANT
ROCK ISLAND AIRPORT
DRAINAGE DIVIDE
ROCK RIVER
NOTE - INVERTED SIPHON USED FROM POINTS "B" AND "C" AT ELEV. 580.00 TO POINT "A" AT ELEV. 574.00 TO ELIMINATE PUMPING OF SEWAGE FROM SOUTHEAST AREA OF CITY
STATE PARK
RESORT AREA
N
LEGEND
AREA TOO LOW FOR SERVICE WITHOUT PUMPING.
ALL STORM WATER FROM THIS AREA OF CITY TO BE PUMPED WHEN RIVER STAGE IS ABOVE ELEV. 548.00. — CAPACITY OF PUMPS IS 260 M.G.D. — LOW WATER POOL OF MISSISSIPPI RIVER IS AT ELEV. 544.00 ± HIGH WATER ELEV. 560.00.
INTERCEPTING SEWER — DRY WEATHER FLOW ONLY.
COMBINED INTERCEPTOR AND STORM RELIEF SEWER.
GRAVITY DISCHARGE SEWERS INTERCEPTING HILL WATER. FORCE MAIN SECTION USED THROUGH LOWLANDS.
DRAINAGE DIVIDE.
ALL SEWERS TO SOUTH AND EAST DRAINING TOWARD ROCK RIVER BEING CONVERTED TO SEPARATE SYSTEM ON ACCOUNT OF DAM, LAKE AND PLEASURE RESORTS LOCATED ON ROCK RIVER.
TRUNK RELIEF SEWER (COMBINED)
NOTE — SEWERED AREA CORRESPONDS WITH SUBDIVIDED AREA. ALL STREETS SHOWN SUBDIVIDED ARE SERVED WITH SEWERS.
ROCK ISLAND, ILL.
INTERCEPTING & RELIEF SEWERS
CONSOER, TOWNSEND & QUINLAN
CONSULTING ENGINEERS
CHICAGO, ILL.

LOCK JOINT PIPE

used for Intercepting and Relief Sewers at ROCK ISLAND, ILL.



- *Above — Typical Lock Joint manufacturing yard.*
- *Left — Twin Sewers — 54" sanitary and 72" storm sewers at Rock Island.*

● To minimize the flood menace and to provide adequate sewerage facilities, Rock Island is now completing a modern sewerage system.

Over 78,000 ft. of Lock Joint Reinforced Concrete Pipe is being used in this system. The pipe ranges from 24" to 108" in diameter and was manufactured by local labor in a plant erected at Rock Island especially for this job.

Today's Cities require adequate and efficient sewerage systems. Lock Joint Sewer Pipe meets all of the requirements for modern service. Since 1905 Lock Joint Concrete Pipe has been used extensively throughout the United States and Canada because of its High Strength, Durability, High Carrying Capacity and Adaptability to all laying conditions.

For prices and data consult our nearest permanent plant in any one of these cities:—

Chicago, Ill.
Cleveland, Ohio
Denver, Colo.
Great Bend, Kan.
Hartford, Conn.
Kansas City, Mo.
Kenilworth, N. J.
Rock Island, Ill.
Valley Park, Mo.
White Plains, N. Y.

LOCK JOINT *Plain and Reinforced* CONCRETE PIPE

LOCK JOINT PIPE CO. Established 1905 AMPERE, N. J.

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

PARK RIVER CONDUIT HARTFORD, CONN.

OWNER: U. S. Engineer Office, Providence, R. I.; Lt. Col. J. S. Bragdon, district engineer.

PROJECT: Constructing reinforced concrete conduit about 5,600 ft. long and extending from inlet structure in bed of Park River across Bushnell Park to Hudson St., thence in bed of Park River about 3,300 ft., and thence about 200 ft. across Dutch Point to an outlet structure on bank of Connecticut River. Trench through park to be refilled and surface restored. In river channel filling to be placed beside and over conduit. Side drains of tile and crushed stone to be constructed. Earth dike at inlet, and rock riprap and rock fill at inlet and outlet.

CONDITIONS: Contractor to furnish all materials and complete work in 1,050 calendar days. Rail, highway and water transportation facilities available. In connection with work near railroad care must be taken not to interrupt traffic. Sewer and drain work in connection with conduit to be synchronized with similar work by city and utility companies. Wages on project are: skilled labor, $1.00 to $1.65 per hr.; semi-skilled, 65 to 85c.; and common, 50c. per hr.

BIDS: Eleven bids were opened August 23, 1940, ranging from the contract low of $2,877,784 to $4,298,857. Engineer's estimate, $3,360,030.

LIST OF BIDDERS:

1. B. Perini & Sons, Inc., Framingham, Mass. (contract) $2,877,784
2. C. & R. Construction Co., Roslindale, Mass 2,991,720
3. P. J. Carlin Constr. Co. and Cogan Bros., Inc., New York, N. Y. 3,190,785
4. V. Barletta Co., Roslindale, Mass 3,330,525
5. Del Balso Constr. Corp., New York, N. Y. 3,346,813
6. G. L. Tarlton Contractor, Inc., St. Louis, Mo. 3,471,875
7. Arthur A. Johnson Corp. and Necaro Co., Inc., Long Island City, N. Y. 3,667,333
8. Al Johnson Constr. Co., Minneapolis, Minn. 3,680,170
9. Arundel Corp., Baltimore, Md. 3,796,590
10. Woodcrest Constr. Co. and Rosoff Bros., Inc., New York, N. Y. 3,834,802
11. S. A. Healy Co., White Plains, N. Y. 4,298,857

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Preparation of site	L.S.	$5,000.00	$71,000.00	$20,000.00
2. Stripping topsoil	7,000 c. y.	1.31	.40	.50
3. Com. excav., E. of Bushnell Pk.	66,000 c. y.	1.31	1.90	1.60
4. Com. excav., Bushnell Pk., inlet	128,000 c. y.	1.31	1.90	1.60
5. Com. excav., dredging at outlet	3,000 c. y.	1.31	1.00	1.00
6. Rock excavation	75,000 c. y.	1.31	1.90	1.60
7. Remove exist. masonry	2,400 c. y.	1.31	10.00	7.00
8. Wood sheeting, left in place	200 M bm.	40.00	40.00	10.00
9. Steel shoring, left in place	10,000 lb.	.07	.08	.02
10. Handling water and sewage	L.S.	50,000.00	217,000.00	150,000.00
11. Earth dike	20,000 c. y.	.35	.25	.50
12. Gravel drive	350 c. y.	3.00	3.00	4.00
13. Gravel bedding	700 c. y.	4.00	3.00	3.00
14. Earth backfill, ordinary	120,000 c. y.	.27	.25	.40
15. Earth backfill, impervious	1,000 c. y.	1.00	1.00	.50
16. Rock fill	5,000 c. y.	4.00	1.00	4.00
17. Riprap, hand placed	1,200 c. y.	4.50	6.00	5.00
18. Graded stones, sidedrains	1,300 c. y.	5.00	3.00	5.50
19. 12-in. vit. pipe, sidedrains	7,000 l. f.	.85	.80	.80
20. 8-in. vit. pipe, surf. drains	100 l. f.	1.50	.60	.60
21. 10-in. vit. pipe, surf. drains	100 l. f.	1.60	.70	.80
22. 12-in. vit. pipe, surf. drains	100 l. f.	1.75	.90	1.00
23. 18-in. vit. pipe, surf. drains	100 l. f.	2.25	1.70	2.00
24. 21-in. vit. pipe, surf. drains	1,000 l. f.	2.50	2.00	3.00
25. 24-in. vit. pipe, surf. drains	2,800 l. f.	2.60	2.55	3.50
26. 48-in. concrete pipe	210 l. f.	15.00	8.00	9.00
27. 24-in. concrete pipe	70 l. f.	7.00	2.50	3.00
28. Portland cement	141,000 bbl.	2.30	2.45	3.00
29. Concrete masonry	103,000 c. y.	10.00	8.00	9.00
30. Stone masonry	350 c. y.	10.00	8.00	20.00
31. Concrete fill	1,600 c. y.	10.00	6.50	7.00
32. Brick masonry	200 c. y.	50.00	30.00	30.00
33. Reinforcing steel	16,000,000 lb.	.0425	.04	.047
34. Steel sheet piling	1,250 s. f.	1.20	1.30	1.10
35. Concrete piles	94,000 l. f.	2.20	1.85	2.40
36. Timber piles	15,200 l. f.	.60	.85	.90
37. Steel piles	260,000 lb.	.04	.04	.04
38. Remove timber piles	200 ea.	20.00	5.00	7.00
39. Misc. iron and steel	35,000 lb.	.13	.15	.17
40. Steel sewer pipe	33,000 lb.	.10	.08	.13
41. Cast iron pipe and fittings	88,000 lb.	.10	.10	.10
42. Miscellaneous gates	L.S.	3,500.00	2,500.00	5,000.00
43. Copper water stops	50,000 lb.	.45	.50	.70
44. Topsoil	6,000 c. y.	1.00	1.00	.80
45. Seeding and sodding	5,000 s. y.	.20	.10	.16
46. Drilling grout holes	400 l. f.	5.00	1.00	6.00
47. Pressure grouting	600 c. f.	1.25	1.00	2.50
48. Temporary pavement	800 s. y.	1.50	2.00	2.00

BULKHEAD WALL AND SEWERS NEW YORK

OWNER: City of New York, Stanley M. Isaacs, President, Borough of Manhattan; L. C. Hammond, engineer.

PROJECT: Construction of bulkhead wall, sewers and fill, Marginal Street from E. 30th to E. 36th Street. Involves preparation of site, dredging work, construction of bulkhead wall faced with granite; pier between E. 35th and E. 36th Streets; construction of flat topped reinforced concrete sewers on reinforced concrete platform; and all necessary fill.

CONDITIONS: Contractor to furnish all materials and complete work in 415 calendar days. Rail, highway and water transportation facilities available. Wage rates are: skilled labor, $1.50 to $2.00 per hr.; semi-skilled, 70c. to $1.42; and common labor, 50c. to $1.50 per hr. Dredge workers rates range from 70c. to $1.20 per hr.

BIDS: Five bids were received July 25, 1940, ranging from the contract low of $1,244,691 to $1,568,670.

LIST OF BIDDERS:

1. Allen N. Spooner & Sons, Inc., New York, N. Y. (contract) $1,244,691
2. Centaur Construction Co., Inc., New York, N. Y. 1,309,850
3. Reiss & Weinsier, Inc., Brooklyn, N. Y. 1,508,528
4. Frederick Snare Corp., New York, N. Y. 1,520,869
5. Merritt-Chapman & Scott Corp., New York, N. Y. 1,568,670

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Dredging	100,000 c. y.	$0.637	$0.65	$0.60
2. Remove exist. struct.	L. S.	81,297.00	135,000.00	114,000.00
3. Timber piles, creosoted	268,000 l. f.	.91	1.10	.93
4. White oak fender piles	3,500 l. f.	.533	.75	.90
5. Sheet steel piling	1,300 ton	80.41	85.00	81.00
6. Reinforcing steel	460,000 lb.	.0537	.05	.07
7. Riprap	43,000 c. y.	2.23	1.95	2.70
8. Stone ballast	350 c. y.	3.47	5.00	6.00
9. Sand fill	200,000 c. y.	.6825	.65	.95
10. Ordinary fill	100,000 c. y.	.105	.15	.25
11. Granite facing	8,350 s. f.	3.27	3.00	4.50
12. Independent fender system	1,840 l. f.	9.83	8.00	14.00
13. Creosoted lumber	41 Mbm.	269.50	200.00	200.00
14. Untreated lumber	74 Mbm.	178.20	100.00	190.00
15. 18-in. x ½-in. steel piles	6,840 l. f.	11.12	7.00	6.50
16. 12-in. x ½-in. steel piles	6,800 l. f.	4.65	5.00	4.50
17. Cleats, mooring posts and roller chocks	17,400 lb.	.195	.115	.12
18. Sewer manholes, complete	27 ea.	90.00	100.00	100.00
19. Submerged dropwell manhole	L. S.	11,951.00	28,000.00	13,000.00
20. Overflow chamber	L. S.	10,752.00	15,000.00	30,000.00
21. Twin 6-ft. by 8-ft. flat topped rein. conc. sewer	430 l. f.	124.00	80.00	220.00
22. 8-ft. by 6-ft. fl. top. rein. conc. sewer	45 l. f.	43.00	35.00	50.00
23. 1-ft. by 3-ft., as above	15 l. f.	38.00	12.00	15.00
24. 4-ft. by 2-ft. 4-in., as above	1,320 l. f.	35.00	15.00	70.00
25. C. I. pipe submerged sewer	80 l. f.	144.00	150.00	250.00
26. 18-in. c. i. pipe sew., on conc. cradle	100 l. f.	15.30	10.00	17.00
27. 12-in. c. i. pipe sleeves	120 l. f.	4.10	3.00	7.00
28. Structural steel	446,000 lb.	.048	.104	.106
29. Temp. wooden fence	1,000 l. f.	3.45	1.50	2.00
30. Receiving pit on wood pier	L. S.	7,720.00	5,000.00	7,000.00
31. Anchors, in place	14 ea.	263.65	300.00	1,000.00
32. Ties, in place	1,680 l. f.	6.18	7.00	16.50
33. Stubs, type A	27 ea.	48.00	50.00	100.00
34. Stubs, type B	4 ea.	86.00	50.00	100.00
35. Anchors, in place	4 ea.	631.00	500.00	1,500.00
36. Underwater inspections	100 hr.	12.00	20.00	20.00
37. Concrete, in place	8,200 c. y.	12.96	18.00	12.50

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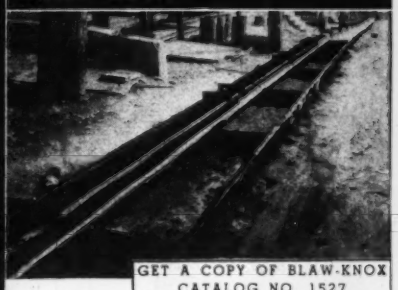

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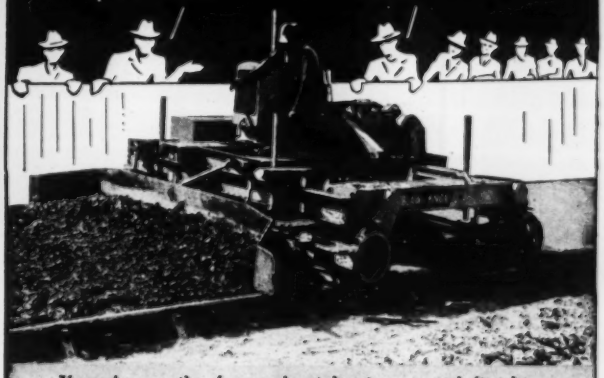

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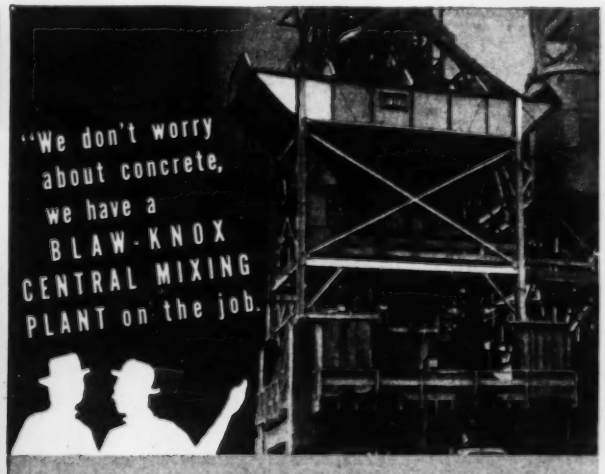

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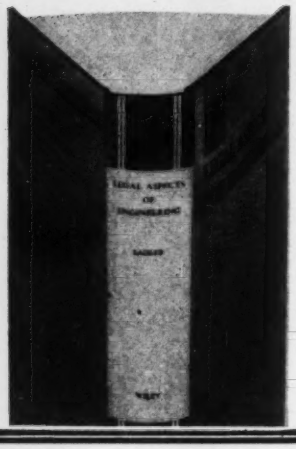

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INDEX OF REPORTS, 1934-1939—National Resources Committee, National Planning Board and the National Resources Planning Board, Washington, D. C. Obtainable from Superintendent of Documents, Washington, D. C.

CALCIUM CHLORIDE SURFACE CONSOLIDATED ROADS—Methods, materials and equipment for construction and maintenance. May be obtained from the Solvay Sales Corporation, 40 Rector St., New York City.

PORTLAND CEMENT—Theories (Proven and Otherwise) and Specifications. By P. H. Bates, fifteenth Edgar Marburg lecture. May be obtained from the American Society for Testing Materials, 260 S. Broad St., Philadelphia. Price 50c.

ASPHALTIC MIXTURES IN BASES—By W. R. Macatee. Published by The Simplicity System Company, Riverside Drive, Chattanooga, Tenn.

SUBDRAINAGE WITH TONCAN DRAINAGE PRODUCTS—Published by the Toncan Culvert Manufacturers' Association, Cleveland, Ohio.

NEW YORK, DIVISION OF WATER POWER AND CONTROL—Thirteenth Annual Report (for year ending Dec. 31, 1939). Issued by the Conservation Department, State of New York, Albany.

READING, MASS., Annual Report of the Board of Public Works (for year ending Dec. 31, 1939).

DETROIT, MICH., 33rd Annual Report, Board of Road Commissioners, County of Wayne.

SOUTH JERSEY PORT COMMISSION, 14th Annual Report to the Legislature of New Jersey.

LONDON, ENGLAND, Metropolitan Water Board, 33rd Annual Report—Published by P. S. King & Son, Ltd., Westminster, London. Price 10s. 6d.

FIFTH ANNUAL REPORT OF THE COUNTY ROAD ENGINEER—1939. King County, State of Washington.

NEW BEDFORD, MASS.—Annual Report of the Commissioner of Public Works. 1939, and Report of the Water Board. 1939.

ST. PAUL, Minn.—58th Annual Report of Board of Water Commissioners, 1939.

ILLINOIS STATE WATER SURVEY—Bulletin No. 21, Supplement II. Issued by State Water Survey Division, Urbana.

LOUISIANA—Report of the Board of State Engineers to the Governor. 1938-1940.

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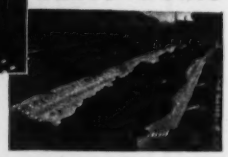

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